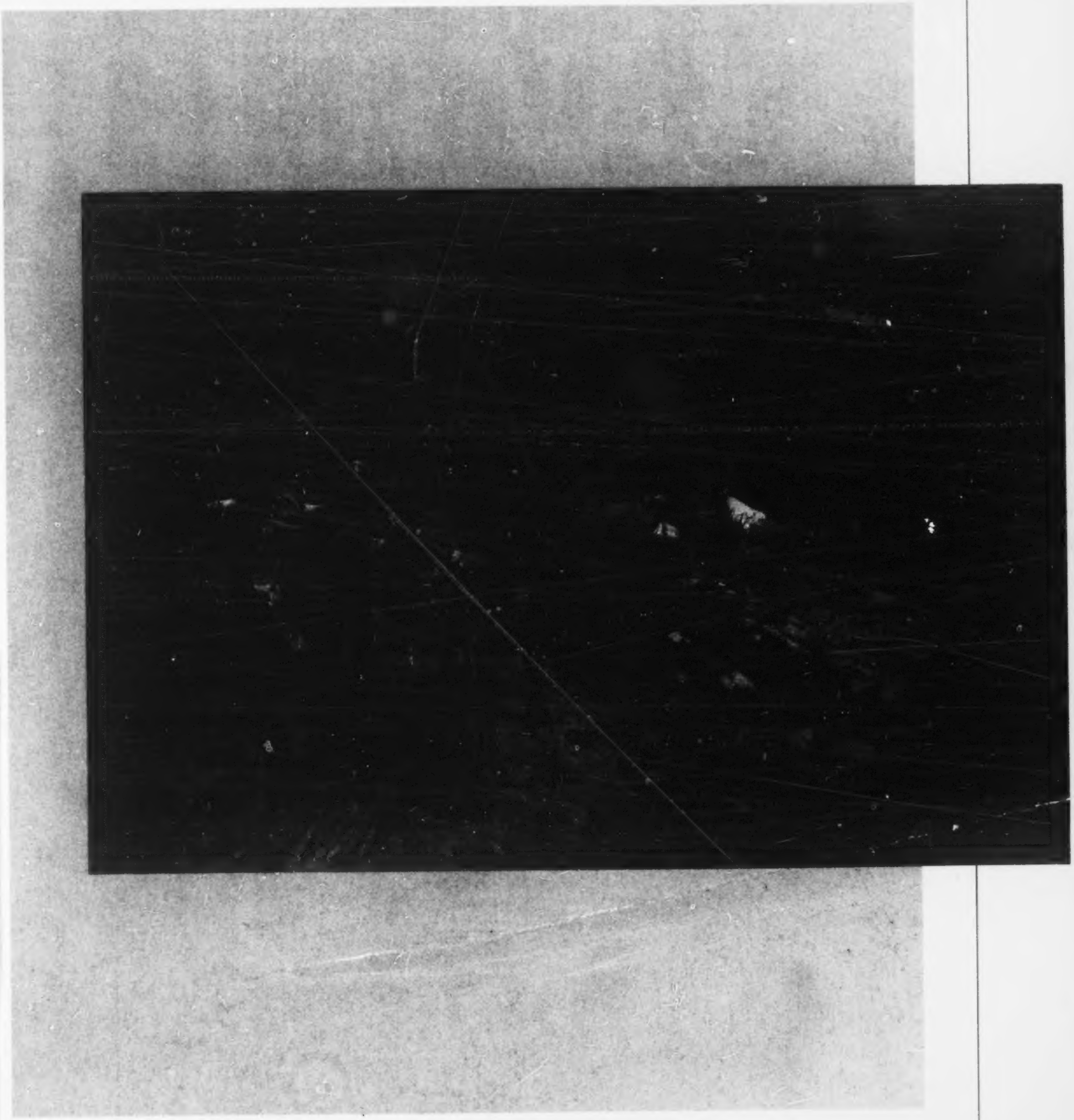
11/4/88

November 1, 1988, Volume 193, Number 9

JOURNAL OF THE AMERICAN VETERINARY MEDICAL ASSOCIATION



800185262 1 110188 2 23 J
CONGRESSIONAL INFO SERV ##
MR ED KIANKA STAT REF INDEX ##
4520 EAST WEST HWY ##
BETHESDA MD 20814 ##

JOURNAL
OF THE AMERICAN VETERINARY MEDICAL ASSOCIATION

©American Veterinary Medical Association, 1988
All Rights Reserved

Vol 193 November 1, 1988 No. 9
JAVMA 193(9) 1013-1212 (1988)
ISSN 0003-1488

Letters

Call for action on violation of practice acts ... 1017

News

AVMA Forum Generates Dialogue on Genetic Engineering ... 1021
Florida VMA Nominates Dr. Pinkerton for President-Elect ... 1024
Council on Veterinary Service Takes Actions ... 1025
Is It Ethical to Patent Surgical Techniques? ... 1025
AVMA Members Are Asked To Review Their Waste Disposal Practices ... 1026
Fur Flies Over Ferret Issue ... 1028
FTC Is Focusing Its Investigation on Ethical and Pet Insurance Guidelines ... 1034
Certification Examinations ... 1037
State Board Examinations ... 1037
Deaths ... 1038

Legal Brief

Limitations on the right to practice veterinary medicine — *Harold W. Hannah* ... 1040

Reflections . . .

Looking back with appreciation: 1988–1933 — *Sydney Rosenberg* ... 1042

Zoonosis Update

Tuberculosis — *Charles O. Thoen* ... 1045

Special Report

Advances in canine diabetes mellitus research: Etiopathology and results of islet transplantation — *Rodolfo Alejandro, Edward C. Feldman, Frances L. Shienvold, and Daniel H. Mintz* ... 1050

Veterinary Services Market for Companion Animals

Dog owners and their use of veterinary services — *C. Michael Troutman* ... 1056

Insurance Note

Fraud in health claims — *Dennis Hyland* ... 1060

Special Commentary

Farmers in distress: How veterinarians can help out — *Roger T. Williams* ... 1062

Forum

Diagnosis and treatment of food animal educational diseases—*Allen D. Leman* ... 1066

ECG of the Month

Richard S. Hawe ... 1070

Interpretive Summaries of Articles in This Issue ... 1072

Reports of Original Studies

Breeding soundness examination of yearling beef bulls—*J. C. Spitzer, F. M. Hopkins, H. W. Webster, F. D. Kirkpatrick, and H. S. Hill* ... 1075

Frequency and antimicrobial susceptibility of *Staphylococcus* spp isolated from feline skin lesions—*Linda Medleau and Jack L. Blue* ... 1080

Clinical Reports

A propagating epizootic of equine infectious anemia on a horse farm—*Richard F. Hall, Alfred R. Pursell, John R. Cole, Jr., and Bronze C. Youmans* ... 1082

Surgical repair of urethral transection in a horse—*Rory J. Todhunter and Jill E. Parker* ... 1085

Congenital inguinal hernias associated with a rent in the common vaginal tunic in five foals—*G. H. Spurlock and J. T. Robertson* ... 1087

Visceral leishmaniasis in an English Foxhound from an Ohio research colony—*Cheryl L. Swenson, Jerald Silverman, Paul C. Stromberg, Susan E. Johnson, David A. Wilkie, Kathryn A. Eaton, and Gary J. Kociba* ... 1089

Acquired cutaneous lymphangiectasis in a dog—*Stephen D. White, Johann G. Thalhammer, Michael Pavletic, Rosemarie Williams, David Kerr, and David Garlick* ... 1093 paternity dispute—*Michel Georges, Pascale Hilbert, Anne-Sophie Lequarré, Véronique Leclerc, Roger Hanset, and Gilbert Vassart* 1095

Hypercalcemia associated with rodenticide poisoning in three cats—*Frances M. Moore, Michele Kudisch, Keith Richter, and Alicia Faggella* 1099

Phaeohyphomycosis caused by *Alternaria alternata* in a cat—*Cheryl R. Dhein, Charles W. Leathers, Arvind A. Padhye, and Libero Ajello* 1101

Reports of Retrospective Studies

Pancreatic abscess in dogs: Six cases (1978–1986)—*S. Kathleen Salisbury, Gary C. Lantz, Richard W. Nelson, and Evelyn A. Kazacos* 1104

Effects of corticosteroid treatment on survival time in dogs with chronic hepatitis: 151 cases (1977–1985)—*Donald R. Strombeck, Lisa M. Miller, and Doris Harrold* 1109

Topics in Drug Therapy

Uses of vincristine and vinblastine in dogs and cats—*Dennis L. Golden and Vernon C. Langston* 1114

The Contributions of Biomedical Research to Animal Health

Foreword—*Dennis O. Johnsen* 1118

Introduction—*Katherine L. Bick* 1119

The potential of biotechnology for improving animal health and productivity—*W. M. Henderson* 1120

Studies of animal oncology with relevance to biomedical advances—*Gordon H. Theilen* 1124

Research on genetic diseases: Reciprocal benefits to animals and man—*D. F. Patterson, M. E. Haskins, P. F. Jezyk, U. Giger, V. N. Meyers-Wallen, G. Aguirre, J. C. Fyfe, and J. H. Wolfe* 1131

Contributions of biomedical research to veterinary surgery—*Anthony Schwartz* 1145

The dog as a model for ocular manifestations of high concentrations of blood sugars—*M. Wyman, S. Sato, Y. Akagi, H. Terubayashi, M. Datiles, and P. F. Kador* 1153

hemostasis research—*W. Jean Dodds* 1157

Social interactions and the coordination of reproductive behavior in rodents and nonhuman primates—*John G. Vandenbergh* .. 1161

Fertility studies for the benefit of animals and human beings: Development of improved sterilization and contraceptive methods—*Bonnie S. Dunbar and Eric Schwoebel* 1165

What Is Your Diagnosis?

David G. Wilson, Beth Paugh Partington, and Marcy Rose 1171

New Veterinary Biological Products .. 1113

Book Reviews

Zoonoses and Communicable Diseases Common to Man and Animals 1092
Reproductive Clinical Problems in the Dog .. 1098
Antimicrobial Therapy in Veterinary Medicine 1100

Abstracts of Selected Reports

Histopathologic effects of dimethyl sulfoxide on equine endometrium 1079
Efficacy of water vapor-saturated air in the treatment of exercise-induced pulmonary hemorrhage in Thoroughbred racehorses 1094

Announcements

Coming Meetings 1174
Foreign Meetings 1176
Educational Opportunities 1178
Applications for Membership 1190

Classified Ads 1193

About the cover

"The Overturned Oxcart (The Unfortunate Farmer)" was painted in 1875 by German artist, Heinrich von Zügel (1850–1941). The artist, originally named Zügel, was the son of a sheep farmer. Zügel was a self-taught artist who became highly regarded as an animal painter by the turn of the century. He received the patent of nobility in 1907, after which he was known as Heinrich von Zügel. Most of the artist's paintings were large oils depicting agricultural scenes, particularly those in which cattle or sheep are with farmers, in herds, or in pastures. The 18¾ × 26½ inch oil-on-canvas reproduced on the cover is typical of von Zügel's early realistic style.

Reproduction of this painting (gift of the Rene von Schleinitz Foundation) was made possible through the Milwaukee Art Museum.

Veterinary Services Market for Companion Animals

Dog owners and their use of veterinary services

The Charles, Charles Research Group recently completed a study of the US market for companion animal veterinary services.[1] A summary of major findings from the study was presented in the Oct 15 issue of the *JAVMA* as the first of a 5-part series covering the full report. This second article presents important findings regarding dog ownership. In addition, dog-owning households use of and expenditures for veterinary services are addressed.

Dog ownership statistics

In a survey of 29,535 nationally representative households, 38.2% (11,287) owned one or more dogs on Dec 31, 1987. Most dog-owning households had only 1 dog, although 30% had 2 or more dogs. Overall, the mean number of dogs owned was 1.5.

When projected to the total of 90.7 million households at the end of 1987, the estimated number of dog-owning households on Dec 31, 1987 was 34.7 million. Also, the projected population of dogs owned at the end of 1987 was 52.4 million.

Dog ownership varied by geographic region. The northeastern region had the lowest percentage (32.1%) of dog-owning households (Table 1). In contrast, the southern region had the highest percentage (41.4%) of dog ownership.

In the survey, dog owners were asked to identify their dogs' age brackets. Almost 40% of dogs were in the 2- to 5-year-old bracket, and just over 25% were in the 6- to 10-year-old bracket. In comparison, 20% were in the ≤1-year-old bracket, and another 15% were >10 years old.

If a household owned a dog, there was a 50% chance that household had another species of companion animal. The most common was a cat, with 42% of owners reporting cat ownership. Besides cats, 11% had pet birds and 6% had a horse.

Demographic profile of dog owners

Four demographic variables that differentiate dog-owning households from households that do not own a companion animal are household income, family size, home ownership, and city population. Table 2 illustrates how these variables differentiate the 2 groups. For example, the percentage of dog owners in the <$20,000 bracket (33%) was less than the corresponding percentage for the "non-owner" group (43%). Conversely, a higher percentage of dog owners was in the ≥$30,000 bracket (49% vs 39%). Therefore, dog ownership appears to be positively correlated with annual household income.

Differences between dog-owning and non-dog-

Table 1—Percentage of dog-owning households by US region

US region*	No. households surveyed	No. (%) dog-owning households†	Margin of error‡
Northeast	6,378	2,047 (32.1)	±1.2%
North Central	7,602	2,879 (37.9)	±1.1
South	9,851	4,079 (41.4)	±1.0
West	5,704	2,282 (40.0)	±1.3
Total	29,535	11,287 (38.2)	±0.6

*Regional designations are same as those used by US Census Bureau. †Number of dog-owning households includes only those that owned one or more dogs on Dec 31, 1987. ‡Margin of error determined with 95% confidence interval.

Table 2—Comparison of selected demographic profiles for dog-owning households with households not owning companion animals

Variable	Category	Dog-owning households (%)	Households not owning a companion animal (%)	Difference*
Household income	<$20,000	33	43	−10
	$20,000 to $29,999	18	18	0
	≥$30,000	49	39	+10
Family size	One person	13	37	−24
	Two people	30	36	−6
	Three people	23	12	+11
	Four or more people	34	15	+19
Home ownership	Own/buying	81	68	+13
	Renting	19	32	−13
City population	<50,000	34	24	+10
	50,000 to 1.9 million	38	39	−1
	≥2 million	28	37	−9

*Difference column shows the result of subtracting the percentage for households not owning from the corresponding percentage for dog owners. The differences give an indication of the relative effect of the variable, with larger category differences indicating a greater effect. If a variable had no effect, all category differences would equal zero. The base for calculating percentages is 11,287 for dog-owning households and 12,176 for non-owning households.

Prepared by C. Michael Troutman, PhD, Charles, Charles Research Group, Overland Park, Kan. Second in a series of 5 synopses from the entire report, which became available Sept 15 (*see JAVMA*, Oct 1, 1988, p. 765).

Table 3—Comparison of family life stage profiles for dog-owning households with households not owning companion animals

Family life stage	Household description	Dog-owning households (%)	Households not owning a companion animal (%)	Difference
Young single	One-member household, age <35 years	3	8	−5
Middle-aged single	One-member household, age 35-65 years	7	15	−8
Older single	One-member household, age >65 years	4	14	−10
Young couple	Two members, <45 years old, no children	9	6	+3
Middle-aged couple	Two members, >45 years old, no children	11	12	−1
Retired older couple	Two retirees, >45 years old, no children	8	17	−9
Young parent	Families with children <6 years old, adults <45 years old	18	11	+7
Middle-aged parent	Families with children >6 years old, adults <45 years	19	6	+13
Older parent	Families with children at home, adults >45 years old	21	10	+11
Other*		1	1	

*"Other" refers to individuals living with a roommate. The base for calculating percentages is 11,287 for dog-owning households and 12,176 for non-owning households.

owning households can be seen more clearly in the right-hand column of Table 2, which shows differences between corresponding percentages. In general, the greater the differences, the more important the demographic variable was in differentiating the 2 groups. The pattern of differences for the family size variable illustrates that dog owners are more likely to be larger families. Also, dog owners are more likely to own their home, and to live in a city with a small population.

Another important way to examine dog ownership is family life stage. Table 3 contrasts dog-owning and non-dog-owning households across various family life stages. These life stages embody several key demographic variables including family size, age of the head(s) of household, and presence of children (see life stage descriptions in Table 3). Among singles, for instance, the percentages for non-dog owners were higher than corresponding percentages for dog owners, as evidenced by negative differences. However, the difference was less for young singles than for middle-aged or older singles, which indicates that dog ownership is less common among the older singles groups.

Table 4—Use of veterinary services by households owning one, two, three, or four dogs

	All dog-owning household*	No. of dogs owned†			
		1	2	3	4
Percentage of households that had dog seen by veterinarian	77.6	76.7	81.1	77.2	76.3
Mean number of veterinary visits per dog-owning households	2.4	1.9	2.9	3.8	4.3
Mean number of veterinary visits per dog	1.5	1.9	1.5	1.3	1.1

*Percentage based on a sample of 11,995 households that owned a dog anytime in 1987. †Percentages for subgroups based on samples of 8,182, 2,540, 751, and 241 for households owning 1, 2, 3, and 4 dogs, respectively.

Among the 3 groups of "couples" (ie, no children), relatively more young couples owned a dog (9% vs 6%), but couples were similar to singles in that dog ownership was less common among older couples. In contrast, dog ownership was far more common in households with children (ie, the parent groups). Almost 60% of all dog-owning households were young, middle-aged, or older parents, whereas about one-fourth of non-dog owners were in the parent group. Therefore, the presence of a child or teen in the home is highly correlated with dog ownership.

Use of veterinary services

Dog owners were asked how many times their dog(s) were examined or treated by a veterinarian during 1987. Table 4 presents these findings for the entire sample of dog-owning households, and for subgroups based on the number of dogs owned. Overall, 77.6% of dog owners had a dog examined or treated at least once during 1987. For each subgroup, the percentage that obtained veterinary care was similarly high.

Table 4 shows further that the mean number of veterinary visits per household in 1987 was 2.4, and that the mean number of visits per dog was 1.5. Among the groups, however, 2 patterns were clearly evident. First, as number of dogs owned increased, mean number of visits per household likewise increased. In contrast, the mean number of visits per dog decreased as the number of dogs owned increased. Compared with "1-dog" owners, those who owned 2 or more dogs consumed more veterinary care, but multiple-dog households actually consumed less veterinary care per dog.

Dog owner expenditures for veterinary services and products were estimated by analyzing households that owned only dogs during 1987. Households that owned more than one species of companion animal gave their expenditures for all species, whereas "dog-exclusive" households provided expenditures for just dogs, and their responses gave a better indication of the amount spent for veterinary services for dogs.

There were 5,281 dog-exclusive households that spent an average of $86.73 for veterinary services and products in 1987. On average, this group owned 1.3 dogs and they had each dog examined 1.9 times during the year. Therefore, the estimated cost per dog was $65.36, and the estimated cost per veterinary visit was $34.96. Given the mean number of veterinary visits for the entire sample of dog-owning households, the estimated total expenditures for veterinary care for dogs reached $3,012 million in 1987.

Conclusions and implications

The survey findings show that dog ownership varies among the 4 major US regions. In particular, the northeastern region has the lowest percentage of dog-owning households. In addition, dog ownership appears to be systematically related to several demographic variables. In general, families with childern are more likely to own a dog.

In comparison with other companion animals, dogs receive more veterinary care.[1] Nevertheless, almost one-fourth of dog owners did not obtain veterinary care in 1987, and this group represents a potential market opportunity for the veterinary profession. If these owners could be encouraged to obtain more regular care (eg, once a year), it would significantly boost national demand for veterinary services.

Multiple dog-owning households may be another market opportunity. Compared with those who own one dog, these owners obtain less veterinary care per dog. If they could be encouraged to obtain additional care for each of their dogs, this would significantly boost demand.

---

[1] Charles, Charles Research Group. The veterinary services market for companion animals. Schaumburg, Ill: American Veterinary Medical Association, 1988.

NEED CLIENT INFORMATION?

TO ORDER: Fill in this form and mail it, with your check to:

American Veterinary Medical Association
930 N Meacham Rd, Schaumburg, Illinois 60196

Please send me, postpaid, the following number(s) of pamphlets: (Price is $5.00/hundred.)

_____ CANINE HEARTWORM DISEASE $_____
_____ RABIES _____
_____ CANINE DISTEMPER _____
_____ EXTERNAL PARASITES _____
_____ TRAVELING WITH YOUR PET _____
_____ FELINE PANLEUKOPENIA _____
_____ PETHOOD OR PARENTHOOD _____
_____ CANINE PARVOVIRUS _____
_____ BUYING A HORSE _____
_____ INTERNAL PARASITES IN HORSES _____
_____ ENTEROTOXEMIA IN SHEEP _____
_____ MASTITIS IN DAIRY COWS _____
_____ CALF DIARRHEA _____
_____ BOVINE LEPTOSPIROSIS _____
_____ CANCER IN ANIMALS _____
_____ SLOW VIRUS DISEASES OF SMALL RUMINANTS _____

Enclosed is my check for $_____

PAYMENT MUST ACCOMPANY ALL ORDERS

AMERICAN VETERINARY MEDICAL ASSOCIATION

Name_____
Address_____
City_____
State_____ Zip_____

(Deliveries made by UPS—Please give street address, not P.O. Box Number)

A5100-2
11/23/88

November 15, 1988, Volume 193, Number 10

JOURNAL OF THE AMERICAN VETERINARY MEDICAL ASSOCIATION

The *Human* Side of Veterinary Medicine

Coping with stress 1222

Career Pathways in Veterinary Medicine

Veterinary clinical nutrition 1238

Cost containment of veterinary education 1241

Zoonosis Update

Leptospirosis 1250

Neonatal *Neospora caninum* infection in dogs 1259

Employment, starting salaries, and educational indebtedness of 1988 veterinary graduates 1317

800185262 1 111588 2 23   J
CONGRESSIONAL INFO SERV ##
MR ED KIANKA STAT REF INDEX ##
4520 EAST WEST HWY ##
BETHESDA MD 20814 ##

JOURNAL
OF THE AMERICAN VETERINARY MEDICAL ASSOCIATION

©American Veterinary Medical Association, 1988
All Rights Reserved

Vol 193 November 15, 1988 No. 10
JAVMA 193(10) 1213-1356 (1988)
ISSN 0003-1488

Veterinary Services Market for Companion Animals

Cat owners and their use of veterinary services—*C. Michael Troutman* 1217

The *Human* Side of Veterinary Medicine

Coping with stress—*Jacob Antelyes* 1222

News

Council Recommends Public Relations Projects 1225
Million-Dollar Heartworm Awareness Campaign Wouldn't Cost AVMA a Penny 1225
Public and Institutional Practice Would be Promoted More Vigorously 1227
Are Your Clients Satisfied? 1228
At the Movies: Veterinary Medicine 1228
Certification Examinations 1235
State Board Examinations 1235
Deaths 1236

Career Pathways in Veterinary Medicine

Veterinary clinical nutrition: A new veterinary medical specialty—*Rebecca L. Remillard and Craig D. Thatcher* 1238

Special Commentary

Cost containment of veterinary education—*George C. Shelton* 1241

Zoonosis Update

Leptospirosis—*J. Glenn Songer and A. B. Thiermann* 1250

Interpretive Summaries of Articles in This Issue 1255

Reports of Original Studies

Neonatal *Neospora caninum* infection in dogs: Isolation of the causative agent and experimental transmission—*J. P. Dubey, A. L. Hattel, D. S. Lindsay, and M. J. Topper* 1259
Effect of aspirin, furosemide, and commercial low-salt diet on digoxin pharmacokinetic properties in clinically normal cats—*Clarke E. Atkins, Patti S. Snyder, and Bruce W. Keene* 1264
Inheritance of associated ocular and skeletal dysplasia in Labrador Retrievers—*C. B. Carrig, D. P. Sponenberg, G. M. Schmidt, and H. W. Tvedten* 1269

Clinical Reports

Omphalophlebitis and osteomyelitis associated with *Klebsiella* septicemia in a premature foal—*Wendy E. Vaala, E. Susan Clark, and James A. Orsini* 1273
Hematochezia attributable to cranial mesenteric arterial aneurysm with connecting tracts to cecum and ileum in a horse—*Mary L. Kiper, Charles MacAllister, and Charles Qualls, Jr.* 1278
Lymphocytic enteritis in a filly—*E. Susan Clark, Debra Deem Morris, Douglas Allen, and D. E. Tyler* 1281
Osteochondritis dissecans of the lateral ridge of the talus in a dog—*Rene T. van Ee, Karen Gibson, and Edgar D. Roberts* 1284
Filaroides hirthi infection in two related dogs—*Rhonda D. Pinckney, Arnold D. Studer, and Robert M. Genta* 1287
Medical and surgical management of multiple organ infarctions secondary to bacterial endocarditis in a dog—*Gary W. Ellison, Robert R. King, and Maron Calderwood-Mays* 1289
Psittacine beak and feather disease syndrome in a cockatoo—*Albert E. Jergens, T. P. Brown, and Timm L. England* 1292
Ataxia, arthritis, and encephalitis in a goat herd—*Jeanne Lofstedt, Richard Jakowski, and Patty Sharko* 1295

Reports of Retrospective Studies

Sternothyrohyoideus myectomy in horses: 17 cases (1984–1985) — *I. W. Harrison and C. W. Raker* 1299

Necrosis of the collateral cartilage of the distal phalanx in horses: 16 cases (1970–1985) — *Clifford M. Honnas, Claude A. Ragle, and Dennis M. Meagher* 1303

Review Article

Bovine pneumonic pasteurellosis: Immunity to *Pasteurella haemolytica* — *Anthony W. Confer, Roger J. Panciera, and Derek A. Mosier* 1308

Economic Note

Employment, starting salaries, and educational indebtedness of 1988 graduates of US veterinary medical colleges — *J. Karl Wise* 1317

What Is Your Diagnosis?

Beverly L. Roeder 1319

Book Reviews

Pesticide Use and Toxicology in Relation to Wildlife: Organophosphorus and Carbamate Compounds 1280
Disinfection in Veterinary and Farm Animal Practice 1298
Equine Radiographic Procedures 1320

Abstracts of Selected Reports

Failure to demonstrate transmission of enzootic bovine leukemia virus infection from cows to sheep by use of common injection needles 1277
Response to intradermal skin testing with four cat allergen preparations in healthy and allergic dogs 1302
Evaluation of ivermectin for larvicidal effect in experimentally induced *Parascaris equorum* infections in pony foals 1307

Announcements

Coming Meetings 1321
Foreign Meetings 1324
Applications for Membership 1325
Educational Opportunities 1326

Classified Ads 1339

PUBLICATIONS DIVISION STAFF

Dr. Albert J. Koltveit, *Editor-in-Chief*
Dr. Ann Schola Clark, *Associate Editor*
Dr. Janis H. Audin, *Assistant Editor*
Dr. Nancy W. Leveque, *Assistant Editor*
Dr. Kathleen J. Kovacs, *Assistant Editor*
Bernadine Gordon Clune, *Production Manager*
Kris Piepenburg, *Assistant Production Manager*
Susan Kahler, *News Editor*
Terri Gallatin, *Assistant News Editor*
Charles Hamilton, *Advertising Representative*
Irene Jansons, *Advertising Production Manager*
Opal Anderson, *Advertising Assistant*
Elisabeth Crist, *Editorial Assistant*
Jeri Miller Dale, *Editorial Assistant*
Geraldine Ernst, *Editorial Assistant*
Janice Johnson, *Editorial Assistant*
Rhonda Jones, *Editorial Assistant*
Helen Moscicke, *Editorial Assistant*
Leslie Quinlan, *Editorial Assistant*
Robert Reotutar, *Editorial Assistant*
Nancy Stein, *Advertising Assistant*

AVMA OFFICERS

Dr. Walter L. Martin, Jr., 2223 E 23rd St, Chattanooga, TN 37407, *President*
Dr. Samuel E. Strahm, PO Box 1256, Pawhuska, OK 74056, *President-Elect*
Dr. Jesse D. Derrick, 226 Engram St, PO Box 146, Montezuma, GA 31063, *Vice President*
Dr. Owen R. Stevens, Jr., 99 Portland St, South Berwick, ME 03908, *Treasurer*
Dr. Shelton Pinkerton, 4101 Piedmont Rd, Pensacola, FL 32503, *Chairman of the Executive Board*
Dr. Arthur Freeman, *Executive Vice President*
Dr. Bruce W. Little, *Assistant Executive Vice President*

AVMA SCHAUMBURG OFFICE

American Veterinary Medical Association, 930 N Meacham Rd, Schaumburg, IL 60196. Office hours: 8:30 am to 4:45 pm, Monday through Friday. Telephone toll free: 1-800-248-AVMA (In Illinois: 1-800-233-AVMA). Outside the continental United States call 312-605-8070.

AVMA GOVERNMENTAL RELATIONS DIVISION

Dr. Lawrence E. Miller, 1023 Fifteenth Street, NW, Suite 300, Washington, DC 20005-2602. Telephone: 202-659-2040.

AVMA INSURANCE INFORMATION

To obtain information on the AVMA Group Health and Life Insurance Trust or the AVMA Professional Liability Insurance Trust, call toll free: 1-800-621-6360.

SUBSCRIPTIONS: For one year: members $35; others $70 in the United States and possessions; $90 in foreign countries. Single copies: $6.00 in the United States and possessions; $8.00 in foreign countries.

Published semimonthly at 930 N Meacham Rd, Schaumburg, IL 60196, by the American Veterinary Medical Association. Second class postage paid at Schaumburg, Ill, and at additional mailing offices. Contents copyright 1988 by the AVMA.

ADDRESS CHANGE: Send new address (and moving date) 45 days ahead. Include old address as it appeared on previous issues (if possible send label).

POSTMASTER: Send address changes to JAVMA, 930 N Meacham Rd, Schaumburg, IL 60196.

BPA

Veterinary Services Market for Companion Animals

Cat owners and their use of veterinary services

This is the third of 5 synopses covering the recently completed study of the US veterinary services market for companion animals.[1] This article summarizes findings on cat ownership in the United States. Also, cat-owning households' use of and expenditures for veterinary services are noted.

Cat ownership statistics

In the survey of 29,535 nationally representative households, 30.5% (9,019) reported owning one or more cats on Dec 31, 1987. Households with multiple cats were common, with 42.6% owning 2 or more cats, and these households accounted for 70.2% of all cats. Because there were many multiple-cat households, the mean number of cats owned was 2. When survey findings are projected to the population of US households at the end of 1987, the estimated number of households owning cats on Dec 31, 1987, was 27.7 million, and the population of cats was 54.6 million.

From a regional standpoint, cat ownership was considerably higher in the western region, where 35.8% of households owned a cat (Table 1). In comparison, cat ownership in the north-central region was the lowest (27.0%).

Cat owners provided information about their cats' age brackets, and the most common age bracket was 2 to 5 years; 43% of cats owned were in this bracket. Another 28% were in the ≤1-year-old bracket, and 29% were in the ≥6-year-old bracket. In addition, cat owners were likely to own another species of companion animal. For example, 50% of cat owners reported that they owned a dog, 10% owned a pet bird, and 6% owned a horse.

The percentage of US households owning cats has increased from 28.4% in 1983 to 30.5% at the end of 1987. Other evidence indicates that this growth is part of a long-term trend going back to at least the mid-1970s. For example, researchers with Ralston Purina Company have published survey data on cat ownership dating back to 1975.[2] Reanalysis of those data shows that 21.5% of US households had owned a cat during a 12-month period in 1974 and 1975, and the average number of cats owned was 1.6. In view of current data, there has been a marked increase in the percentage of households owning cats and the average number of cats owned.

Demographic profile of cat owners

In the article on dog owners,[3] it was pointed out that 4 variables were important for differentiating dog-owning households from those that did not own a companion animal: (1) household income, (2) family size, (3) home ownership, and (4) city population. These demographic variables also were related to cat ownership, as shown in Table 2. For

Table 1—Percentage of cat-owning households, by US region

US Region*	No. households surveyed	No. (%) cat-owning households†	Margin of error (%)‡
Northeast	6,378	1,895 (29.7)	± 1.1
North Central	7,602	2,056 (27.0)	± 1.0
South	9,851	3,024 (30.7)	± 0.9
West	5,704	2,044 (35.8)	± 1.2
Total	29,535	9,019 (30.5)	± 0.5

*Regional designations are the same as those used by US Census Bureau. †Number of cat-owning households includes only those that owned one or more cats on Dec 31, 1987. ‡Margin of error determined with 95% confidence interval.

Table 2—Comparison of selected demographic profiles for cat-owning households with households not owning companion animals

Variable	Category	Cat-owning households (%)	Households not owning a companion animal (%)	Difference*
Household income	<$20,000	34	43	− 9
	$20,000 to $29,999	18	18	0
	≥$30,000	48	39	+ 9
Family size	One person	16	37	− 21
	Two people	30	36	− 6
	Three people	21	12	+ 9
	Four or more people	33	15	+ 18
Home ownership	Own/buying	76	68	+ 8
	Renting	24	32	− 8
City population	<50,000	33	24	+ 9
	50,000 to 1.9 million	37	39	− 2
	≥2 million	30	37	− 7

*Difference column shows the result of subtracting the percentage for households not owning a companion animal from the corresponding percentage for cat owners. The differences give an indication of the relative effect of the variable, with larger category differences indicating a greater effect. If a variable had no effect, all category differences would equal zero. The base for calculating percentages is 9,019 for cat-owning households and 12,176 for households not owning a companion animal.

Prepared by C. Michael Troutman, PhD, Charles, Charles Research Group, Overland Park, Kan. Third in a series of 5 synopses from the entire report, which became available Sept 15 (*see JAVMA*, Oct 1, 1988, p 765).

Table 3—Comparison of family life stage profiles for cat-owning households with households not owning companion animals

Family life stage	Household description	Cat-owning households (%)	Households not owning a companion animal (%)	Difference
Young single	One-member household, <35 years old	5	8	−3
Middle-aged single	One-member household, 35 to 65 years old	7	15	−8
Older single	One-member household, >65 years old	4	14	−10
Young couple	Two members, <45 years old, no children	10	6	+4
Middle-aged couple	Two members, >45 years old, no children	10	12	−2
Retired older couple	Two retirees, >45 years old, no children	7	17	−10
Young parent	Families with children <6 years old, adults <45 years old	17	11	+6
Middle-aged parent	Families with children >6 years old, adults <45 years old	18	6	+12
Older parent	Families with children at home, adults >45 years old	20	10	+10
Other*		2	1	

*"Other" refers to individuals living with a roommate. The base for calculating percentages is 9,019 for cat-owning households and 12,176 for households not owning a companion animal.

Table 4—Use of veterinary services by households owning one, two, three, or four cats

	All cat-owning households*	No. of cats owned				
		1	2	3	4	≥5
Percentage of households that had cat seen by veterinarian	59.5	57.2	67.7	63.9	59.8	43.7
Mean number of veterinary visits per cat-owning households	1.6	1.1	2.0	2.6	2.8	2.3
Mean number of veterinary visits per cat	0.8	1.1	1.0	0.9	0.7	0.3
Base†	9,019	5,335	2,278	826	388	701

*Percentage based on a sample of 9,528 households that owned a cat anytime in 1987. †The base in each column is the sample size used in calculating percentage and means for the respective groups.

example, the percentage of cat-owning households with annual incomes of $30,000 or more is considerably greater than the corresponding percentage for non-owners, which indicates that cat-owning households had higher annual incomes. Similarly, cat ownership increased as family size increased. Moreover, cat owners tended to own their own home and to live in cities with small populations.

Another way to compare cat-owning with non-cat-owning households is on the basis of family life stage (Table 3), based on family size, age of head(s) of household, and presence of children. For example, there are 3 single life stages (young, middle-aged, and older), and the percentages of cat-owning households in these 3 groups are less than the corresponding percentages for households not owning a companion animal. However, the difference is less for young singles than for middle-aged or older singles, which indicates that cat ownership was less common among the latter 2 groups. The same trend is evident for the 3 couple life stages (young, middle-aged, and retired).

In the 3 parent life stages (young, middle-aged, and older), however, the trend is just the opposite. Here, the likelihood of cat ownership increased from young to older parents. Even more important is the fact that cat ownership was more common for all 3 groups of parents. On a combined basis, 55% of cat-owning households have children. These findings resemble those for dog-owning households, and they underscore the important relationship between pet ownership and presence of children in the household.

Use of veterinary services

Regarding cat owners' use of veterinary services during 1987 (Table 4), 59.5% had a cat seen by a veterinarian. Comparable percentages are shown for subgroups based on number of cats owned. Among subgroups, the percentages that obtained care were generally well above 50%, except for households with ≥5 cats, where the percentage was 43.7%.

Further, the mean number of veterinary visits per household was 1.6, and the mean number of visits per cat was 0.8. Across subgroups, the mean number of visits per household increased with the increase in number of cats owned; however, visits per household dropped to 2.3 for those with ≥5 cats. On a per-cat basis, visits decreased slightly with the increase in number of cats owned, although a sharp decline appears for those with ≥5 cats.

Notwithstanding those who owned ≥5 cats, results indicate that most owners had each cat seen by a veterinarian about once a year. This reflects an overall increase in cat owners' use of veterinary services.[1] Despite this increase, cats receive substantially less veterinary care than dogs. On a per-pet basis, the mean number of annual veterinary visits was 1.5/dog vs 0.8/cat. This is also the pattern in households with both a dog and a cat, and this suggests that many owners believe cats need less veterinary care than dogs.

Cat owner expenditures for veterinary services and products were estimated by analyzing households that owned only cats during 1987. These results were projected to all cat-owning households, based on the average cost of a feline veterinary visit. To illustrate, cat-exclusive households spent an average of $63.83 on veterinary services, and they had their cats examined 1.9 times during the year. Therefore, the average cost per veterinary visit was

$33.59. Given the estimated number of cat-owning households and the mean number of feline veterinary visits per household, estimated expenditures for feline veterinary care were $1.573 billion in 1987.

Conclusions and implications

Cat ownership has become increasingly popular. The percentage of households owning cats has increased dramatically since the mid-1970s. Further, the average number of cats owned has increased in this time.

In many respects, cat-owning households resemble dog-owning households. Like dog owners, for instance, cat owners tend to have higher incomes and larger families, compared with households without a pet. Also, there is a correlation between cat ownership and the presence of children in the household. One reason is the overlap in dog and cat ownership; 50% of cat owners also owned a dog in 1987.

Although most cat owners appear to obtain annual veterinary care, 40% of cat owners did not have their cats examined in 1987. Those who do not obtain annual veterinary care represent an opportunity for increasing pet owner demand for veterinary services. If one third of this 40% group had obtained feline veterinary care in 1987, for example, demand for feline veterinary care would have approached the level of demand for canine care. Therefore, a continuing marketing goal should be to encourage more regular use of veterinary services by cat owners.

---

1. Charles, Charles Research Group. The veterinary services market for companion animals. Schaumburg, Ill: American Veterinary Medical Association, 1988 (in press).

2. Lawler DF, Sjolin DW, Collins JE. Incidence rates of feline lower urinary tract disease in the United States. *Feline Pract* 1985;15:13–16.

3. Troutman CM. Dog owners and their use of veterinary services. *J Am Vet Med Assoc* 1988;193:1056–1058.

INDISPENSABLE IN THE CLASSROOM

A new edition!

HAGAN AND BRUNER'S MICROBIOLOGY AND INFECTIOUS DISEASES OF DOMESTIC ANIMALS

Eighth Edition

By **JOHN F. TIMONEY, JAMES H. GILLESPIE, FREDRIC W. SCOTT,** and **JEFFREY E. BARLOUGH**. The new edition of this widely used classic on the bacterial, fungal, and viral diseases of domestic animals is an extensive revision of the last edition, published in 1981. Meticulously updated and rewritten, it is an indispensable textbook and reference for courses in bacteriology, virology, mycology, infectious diseases, preventive and clinical medicine, veterinary public health, and diagnostic veterinary microbiology. $55.00

FISH VIRUSES AND FISH VIRAL DISEASES

By **KEN WOLF**. This book is a comprehensive, generously illustrated, and up-to-date reference on the virology of fishes. The long-awaited work of a recognized pioneer researcher and authority, it covers some thirty years of research since the first virus was isolated from a fish and describes 63 diseases and agents of viral, viruslike, or of mistaken viral nature. *A Comstock Book*. $57.50.

ASPECTS OF DIGESTIVE PHYSIOLOGY IN RUMINANTS

Edited by **ALAN** and **MARJORIE DOBSON**. This book, consisting of fourteen articles, is an interdisciplinary survey of some of the most recent advances in ruminant research, especially on comparative aspects of the digestive tract. *A Comstock Book*. $39.95

NUTRITIONAL ECOLOGY OF THE RUMINANT

Ruminant Metabolism, Nutritional Strategies, the Cellulolytic Fermentation and the Chemistry of Forages and Plant Fibers

By **PETER J. VAN SOEST**. "This book represents a major synthesis in what has become an increasingly complex field and, because the approach is founded so solidly on comparative nutrition, should be of interest to biologists who work on wild and domesticated herbivores."—*New Scientist*. $32.00

Call 1-800-666-2211 with credit card orders.

Cornell University Press
124 Roberts Place, Ithaca, NY 14850

CORNELL

Economic Note

Employment, starting salaries, and educational indebtedness of 1988 graduates of US veterinary medical colleges

In cooperation with US colleges of veterinary medicine, the AVMA conducted its annual survey of the graduating classes of veterinary medicine in spring 1988. The primary purpose of the survey was to secure data on veterinary graduates' employment, salaries, and educational indebtedness. Of the 2,223 US graduates, 1,472 responded to the survey, a response rate of 66%.

Employment and income

At the time of the survey, 85% of the responding graduates had received at least one employment offer. Of those graduates receiving offers, 35% had received 1 offer, 26% had received 2 offers, and 39% had received 3 or more offers. At the time of the survey, 69% of the graduates had accepted positions for employment upon graduation.

Regarding the graduates who had accepted employment, 75% had accepted positions as employees in private practice (Tables 1 and 2). Mean starting salaries are reported for 828 graduates who indicated annual starting salaries for full-time employment. For graduates taking positions as employees in private practice, the mean starting salary was $23,079. This represents a 4.2% increase over the 1987 starting salary of $22,152 for private practice employees.[1]

Specifically, 37.7% entered small animal exclusive practice at a mean annual salary of $23,550, up 3.8% from 1987; 9.3% entered small animal predominant practice at a mean annual salary of $22,598, up 4.5% from 1987. Also, 14.5% entered mixed animal practice at a mean annual salary of $22,279, up 5.9%. Only 3.0% of graduates entered equine practice, and the mean starting salary was $21,269, down 2.9%. In the livestock sector, 1.9% and 8.4% of graduates entered large animal exclusive and large animal predominant practice, respectively. In large animal exclusive and large animal predominant practice, starting salaries were $24,488, up 3.9%, and $23,214, up 12.0%, respectively. An additional 4.8% of the respondents reported they would be self-employed in private practice, with an expected mean income of $23,690.

Table 1—Types of employment and starting incomes of a large sample of 1988 US veterinary medical college graduates

	Percentage of graduates	Mean starting salary (No.)	Mean additional compensation expected in first year (No.)
Large animal exclusive	1.9	$24,488 (17)	$3,409 (11)
Large animal predominant	8.4	$23,214 (74)	$3,926 (40)
Mixed animal	14.5	$22,279 (123)	$3,073 (70)
Small animal predominant	9.3	$22,598 (80)	$2,883 (53)
Small animal exclusive	37.7	$23,550 (319)	$3,416 (182)
Equine predominant	3.0	$21,269 (26)	$6,250 (16)
University	2.1	$17,700 (14)	$2,950 (4)
Federal government*	...	... ...	... ...
Military service†	1.3	$33,372 (11)	$4,050 (4)
State/local government	0.1	$27,914 (1)	... ...
Industry/commercial	0.7	$35,166 (6)	$3,333 (3)
Advanced study	15.1	$15,766 (119)	$4,063 (23)
Self-employed	4.8	$23,690 (31)	$5,127 (18)
Other	1.0	$21,942 (7)	$4,500 (4)
	100 (894)‡	$22,181 (828)	$3,565 (428)

*Starting salary for federal government employment of veterinarians with no experience, no advanced degree other than the DVM, and not in the top 25% of their class was $22,907 (GS 9, step 1). †Starting salary for military employment for veterinarians who are single, with no prior military service, including base pay, subsistence and quarters allowance, and veterinary special pay was $27,455. ‡Of the 894 graduates reporting employment, 828 reported their annual starting salary for full-time employment.

Prepared by J. Karl Wise, PhD, Wisemark Associates, PO Box 681189, Schaumburg, IL 60168-1189.

Table 2—1988 Starting salaries of 828 US veterinary medical college graduates, by type of employment

Starting salaries	LAE	LAP	MA	SAP	SAE	EP	U	FG	MS	SLG	IC	AS	SE	Other	Total
$11,000 or less	...	3	2	2	3	1	2	...	...	...	...	5	...	...	18
$11,001 to $13,000	...	...	...	1	1	...	2	...	...	...	...	9	1	...	14
$13,001 to $15,000	1	...	2	1	2	2	...	...	...	...	...	38	...	1	47
$15,001 to $17,000	...	...	2	...	2	1	3	...	...	...	...	41	1	...	50
$17,001 to $19,000	...	3	5	4	14	4	3	...	...	...	1	12	1	...	47
$19,001 to $21,000	2	5	30	16	35	7	2	...	...	...	...	10	7	2	116
$21,001 to $23,000	1	17	36	20	93	1	1	...	...	...	...	1	3	1	174
$23,001 to $25,000	6	31	30	23	93	6	...	...	...	...	...	...	9	2	200
$25,001 to $27,000	3	9	11	4	37	1	...	...	...	...	...	3	4	...	72
$27,001 to $29,000	3	2	3	5	19	...	...	...	2	1	1	...	2	1	39
$29,001 to $31,000	1	3	2	3	17	2	...	...	3	...	1	...	2	...	34
$31,001 to $33,000	...	...	...	...	2	...	...	...	1	...	...	...	...	...	3
More than $33,000	...	1	...	1	1	1	1	...	5	...	3	...	1	...	14

LAE = large animal exclusive; LAP = large animal predominant; MA = mixed animal; SAP = small animal predominant; SAE = small animal exclusive; EP = equine predominant; U = university; FG = federal government; MS = military service; SLG = state/local government; IC = industrial/commercial; AS = advanced study; SE = self-employed.

As in 1987, less than 2% of the responding graduates accepted positions with the military service. The mean starting salary was $33,372. No respondents indicated employment with the federal government. One respondent entering state/local government reported a salary of $27,914. Six graduates entering the industry sector reported a mean salary of $35,166.

*Table 3—Educational debt of 1988 US veterinary medical college graduates**

Debt ($)	Relative frequency (%)	Cumulative frequency† (%)
0	16.7	100.0
1 to 5,000	7.9	83.3
5,001 to 10,000	7.0	75.4
10,001 to 15,000	7.9	68.4
15,001 to 20,000	11.0	60.5
20,001 to 25,000	12.6	49.5
25,001 to 30,000	11.8	36.9
30,001 to 35,000	7.2	25.1
35,001 to 40,000	7.0	17.9
40,001 to 45,000	3.4	10.9
45,001 to 50,000	2.7	7.5
More than 50,000	4.8	4.8

*Total respondents = 1,472. †Cumulative frequency percentages represent the percentage of graduates with debt in excess of the corresponding next lowest debt interval; eg, 60.5% of the graduates reported debt in excess of $15,000.

In the academic sector, 2.1% took university positions (research or teaching) at a mean salary of $17,700, and 15.1% would begin advanced study (graduate degree, internship, or residency program) at a mean salary of $15,766.

All graduates were asked if they would receive compensation in addition to their salary in their first year of employment. One half of the graduates who reported starting salaries indicated that they would receive additional compensation within the first year. Most likely, the additional pay represents a percentage of gross income, a percentage of emergency fees, a bonus, a salary raise, or other financial compensation. Most graduates anticipating additional pay expected amounts ranging from $3,000 to $5,000.

Educational debt

All graduates were requested to indicate what their total education indebtedness would be upon graduation. For the 1,226 graduates (83%) who indicated having educational debt, the mean debt was $25,753, up 4.4% from 1987. The relative frequency distribution showed that 60% of 1988 graduates, compared with 63% of 1987 graduates, had educational debt in excess of $15,000 (Table 3).[1] Mean educational debt also was determined by type of employment graduates accepted at the time of the survey (Table 4).

Reference

1. Wise JK. Employment, starting salaries, and educational indebtedness of 1987 graduates of US veterinary medical colleges. *J Am Vet Med Assoc* 1987;191:1489–1490.

Table 4—1988 Educational debt of 761 US veterinary medical college graduates, by type of employment

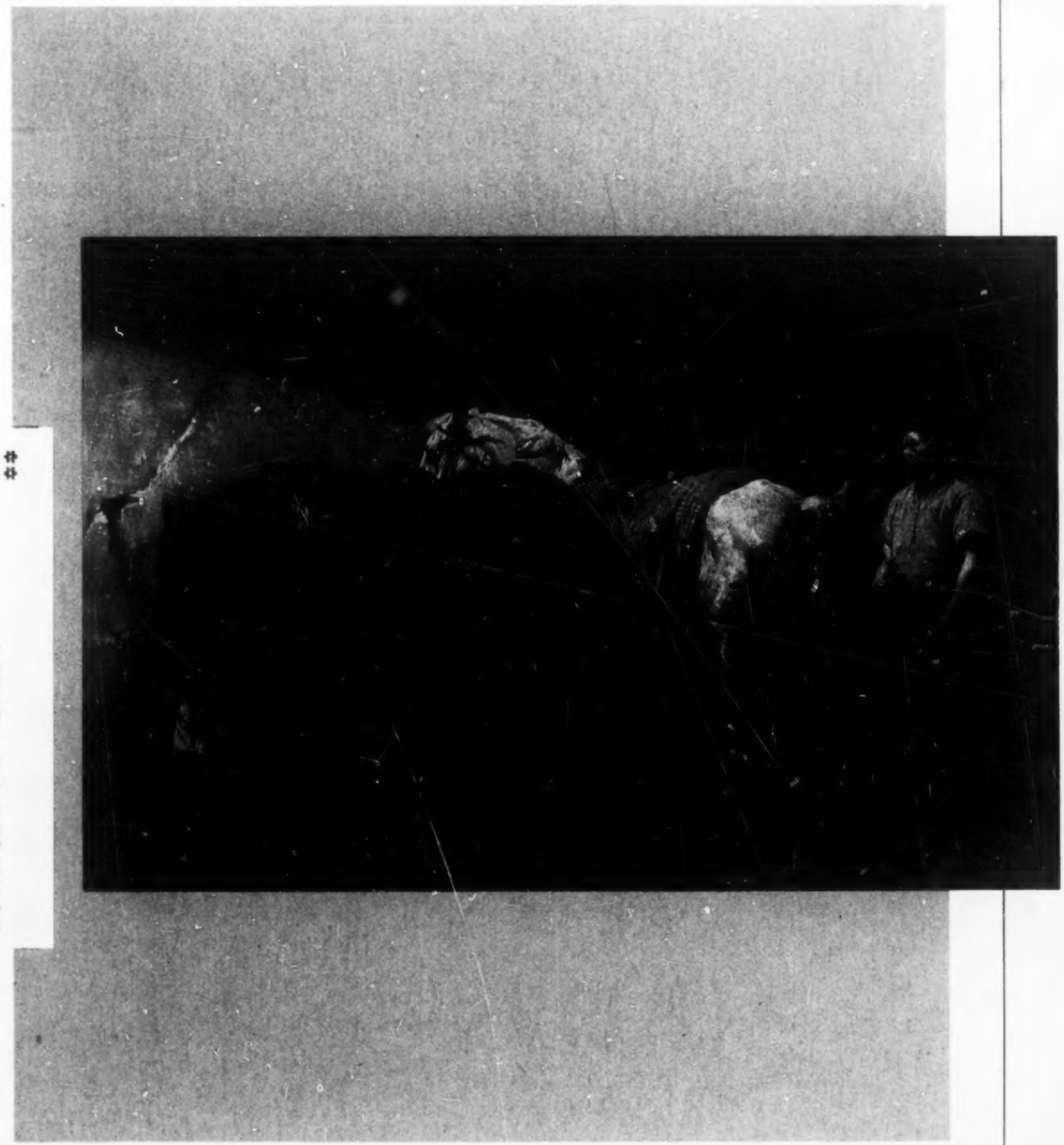
Debt ($)	LAE	LAP	MA	SAP	SAE	EP	U	FG	MS	SLG	IC	AS	SE	Other
1 to 5,000	1	7	15	5	24	4	2	...	1	...	...	13	4	...
5,001 to 10,000	3	5	8	7	25	1	2	...	2	...	...	9	3	1
10,001 to 15,000	...	11	10	3	27	2	2	...	1	...	...	16	2	1
15,001 to 20,000	1	9	16	9	41	1	3	...	2	...	2	8	6	1
20,001 to 25,000	2	12	13	14	38	10	2	...	1	...	1	20	1	1
25,001 to 30,000	4	9	16	12	48	1	...	...	2	...	1	12	4	...
30,001 to 35,000	2	4	13	6	23	1	1	...	1	...	...	4	8	...
35,001 to 40,000	2	6	8	2	21	2	1	...	...	...	...	11	3	2
40,001 to 45,000	...	4	6	2	11	...	1	...	2	1	...	5	...	...
45,001 to 50,000	...	2	2	4	7	...	...	...	...	...	...	5	...	2
More than 50,000	...	1	5	3	19	2	1	...	...	...	1	12	2	...
Total	15	70	112	67	284	24	15	...	12	1	5	115	33	8
Mean	$27,713	$23,371	$24,591	$25,391	$25,720	$24,895	$23,856	...	$22,233	$41,000	$36,700	$27,326	$24,889	$29,750

LAE = large animal exclusive; LAP = large animal predominant; MA = mixed animal; SAP = small animal predominant; SAE = small animal exclusive; EP = equine predominant; U = university; FG = federal government; MS = military service; SLG = state/local government; IC = industrial/commercial; AS = advanced study; SE = self-employed.

A3100-2
12/5/88

December 1, 1988, Volume 193, Number 11

JOURNAL OF THE AMERICAN VETERINARY MEDICAL ASSOCIATION



800135262 1 120188 2 23 J
CONGRESSIONAL INFO SERV **
MR ED KIANKA STAT REF INDEX **
4520 EAST WEST HWY **
BETHESDA MD 20814 **

JOURNAL
OF THE AMERICAN VETERINARY MEDICAL ASSOCIATION

Vol 193 December 1, 1988 No. 11
JAVMA 193(11) 1357-1476 (1988)
ISSN 0003-1488

©American Veterinary Medical Association, 1988
All Rights Reserved

Letters

Hemorrhagic colitis and hemolytic uremic syndrome caused by *Escherichia coli* in people consuming undercooked beef and unpasteurized milk 1360
Clearinghouse for veterinarians wishing to work in developing countries 1361
Flying syringes 1361

Veterinary Services Market for Companion Animals

Horse owners and their use of veterinary services—*C. Michael Troutman* 1362

News

What to Expect Now That Congress Has Created a Veterinary Rx Drug Category 1365
AABP Members Stampede to Calgary 1367
Donating Professional Services: A Matter of Conscience or Ethics? 1372
APHIS Biologics Staff Describes Licensing Process at COBTA Meeting 1374
Certification Examinations 1379
State Board Examinations 1380
Deaths 1380

Reflections . . .

What's past is prologue—*J. Fred Smithcors* ... 1382

Special Commentary

Admissibility of computerized medical records as evidence in a court of law—*Michael F. Philbrick and James F. Wilson* 1386

Insurance Note

Types of professional liability insurance—*Eileen DiFrancesca* 1391

Legal Brief

Malpractice suits and malicious prosecution—veterinarian countersuits—*Harold W. Hannah* 1392

Zoonosis Update

Dog and cat bites—*John R. August* 1394

ECG of the Month

Valerie Fucci 1400

Interpretive Summaries of Articles in This Issue 1402

Reports of Original Studies

Epidural injection of xylazine for perineal analgesia in horses—*P. H. LeBlanc, J. P. Caron, J. S. Patterson, M. Brown, and M. A. Matta* 1405

Diarrhea associated with sand in the gastrointestinal tract of horses—*J. J. Bertone, J. L. Traub-Dargatz, R. W. Wrigley, D. G. Bennett, and R. J. Williams* 1409

Clinical Reports

Cryptosporidiosis in veterinary students—*Jay F. Levine, Michael G. Levy, Richard L. Walker, and Susan Crittenden* 1413

Fatal transesophageal carotid arterial perforation by thorns in a calf—*A. David Weaver and Thomas P. Brown* 1415

Hemoperitoneum caused by rupture of a juvenile granulosa cell tumor in an equine neonate—*S. L. Green, T. E. Specht, S. C. Dowling, A. J. Nixon, J. H. Wilson, and J. B. Carrick* 1417

Hereditary junctional mechanobullous disease in a foal—*Steven R. Frame, Daniel D. Harrington, John Fessler, and Peggy F. Frame* ... 1420

Clinical and clinicopathologic findings in two foals infected with *Bacillus piliformis*—*Kent A. Humber, Raymond W. Sweeney, Judith E. Saik, Thomas O. Hansen, and Charles F. Morris* 1425

Disseminated hemangiosarcoma in a horse—*Jenny E. Johnson, Jill Beech, and Judith E. Saik* 1429

Response to radiation therapy of recurrent lymphangioma in a dog—*Jane M. Turrel, Linda J. Lowenstine, and Larry D. Cowgill* 1432

Intraspinal epidermoid cyst in a dog—*James Tomlinson, Robert J. Higgins, Richard A. LeConteur, and David Knapp* 1435

Paraesophageal hiatal hernia and pyloric obstruction in a dog—*Kristina G. Miles, Eric R. Pope, and Albert E. Jergens* 1437

Treatment of hemangiopericytoma in a dog, using surgical excision, radiation, and a thoracic pedicle skin graft—*Theresa W. Fossum, C. Guillermo Couto, William D. DeHoff, and Daniel D. Smeak* 1440

Reports of Retrospective Studies

Disseminated histoplasmosis in dogs: 12 cases (1981-1986)—*Kenneth D. Clinkenbeard, Rick L. Cowell, and Ronald D. Tyler* 1443

Generalized peritonitis in dogs: 50 cases (1975-1986)—*Giselle Hosgood and S. Kathleen Salisbury* 1448

What Is Your Diagnosis?

Beth Paugh Partington 1451

Book Reviews

Introduction to Veterinary Pathology 1412
Canine and Feline Cardiology 1428
Nutrient Requirements of Swine 1434

Abstracts of Selected Reports

Pathogenesis of blue fox parvovirus on blue fox kits and pregnant vixens 1424
Use of pulsatile intravenous administration of gonadotropin-releasing hormone to induce fertile estrus in bitches 1431
Enhancement of infectious bovine keratoconjunctivitis by modified-live infectious bovine rhinotracheitis virus vaccine 1442

Announcements

Coming Meetings 1453
Foreign Meetings 1455
Applications for Membership 1455
Educational Opportunities 1456

Classified Ads 1461

About the cover

"Passion and Patience" was painted in 1833 by English artist, John Sargent Noble (1848-1896). Noble was a student of Sir Edwin Landseer, England's most admired 19th-century animal painter. Noble's most frequent subjects were hunting dogs, often in Highland settings, otter hounds, and otter hunting. He began exhibiting at the Royal Academy in 1871, and thereafter until 1895, a year before his death.

This oil-on-canvas is from the art collection of Dr. Alex Rosen. The transparency used for reproduction was kindly supplied by Kurt E. Schon, Ltd, New Orleans.

PUBLICATIONS DIVISION STAFF

Dr. Albert J. Koltveit, *Editor-in-Chief*
Dr. Ann Schola Clark, *Associate Editor*
Dr. Janis H. Audin, *Assistant Editor*
Dr. Nancy W. Leveque, *Assistant Editor*
Dr. Kathleen J. Kovacs, *Assistant Editor*
Bernadine Gordon Clune, *Production Manager*
Kris Piepenburg, *Assistant Production Manager*
Susan Kahler, *News Editor*
Terri Gallatin, *Assistant News Editor*
Charles Hamilton, *Advertising Representative*
Irene Jansons, *Advertising Production Manager*
Opal Anderson, *Advertising Assistant*
Elisabeth Crist, *Editorial Assistant*
Jeri Miller Dale, *Editorial Assistant*
Geraldine Ernst, *Editorial Assistant*
Janice Johnson, *Editorial Assistant*
Rhonda Jones, *Editorial Assistant*
Helen Moscicke, *Editorial Assistant*
Leslie Quinlan, *Editorial Assistant*
Robert Reotutar, *Editorial Assistant*
Lea Spencer, *Editorial Assistant*
Nancy Stein, *Advertising Assistant*

AVMA OFFICERS

Dr. Walter L. Martin, Jr., 2223 E 23rd St, Chattanooga, TN 37407, *President*
Dr. Samuel E. Strahm, PO Box 1256, Pawhuska, OK 74056, *President-Elect*
Dr. Jesse D. Derrick, 226 Engram St, PO Box 146, Montezuma, GA 31063, *Vice President*
Dr. Owen R. Stevens, Jr., 99 Portland St, South Berwick, ME 03908, *Treasurer*
Dr. Shelton Pinkerton, 4101 Piedmont Rd, Pensacola, FL 32503, *Chairman of the Executive Board*
Dr. Arthur Freeman, *Executive Vice President*
Dr. Bruce W. Little, *Assistant Executive Vice President*

AVMA SCHAUMBURG OFFICE

American Veterinary Medical Association, 930 N Meacham Rd, Schaumburg, IL 60196. Office hours: 8:30 am to 4:45 pm, Monday through Friday. Telephone toll free: 1-800-248-AVMA (In Illinois: 1-800-233-AVMA). Outside the continental United States call 312-605-8070.

AVMA GOVERNMENTAL RELATIONS DIVISION

Dr. Lawrence E. Miller, 1023 Fifteenth Street, NW, Suite 300, Washington, DC 20005-2602. Telephone: 202-659-2040.

AVMA INSURANCE INFORMATION

To obtain information on the AVMA Group Health and Life Insurance Trust or the AVMA Professional Liability Insurance Trust, call toll free: 1-800-621-6360.

SUBSCRIPTIONS: For one year: members $35; others $70 in the United States and possessions; $90 in foreign countries. Single copies: $6.00 in the United States and possessions; $8.00 in foreign countries.

Published semimonthly at 930 N Meacham Rd, Schaumburg, IL 60196, by the American Veterinary Medical Association. Second class postage paid at Schaumburg, Ill, and at additional mailing offices. Contents copyright 1988 by the AVMA.

ADDRESS CHANGE: Send new address (and moving date) 45 days ahead. Include old address as it appeared on previous issues (if possible send label).

POSTMASTER: Send address changes to JAVMA, 930 N Meacham Rd, Schaumburg, IL 60196.

BPA

Veterinary Services Market for Companion Animals

Horse owners and their use of veterinary services

This is the fourth article in the series that summarizes the AVMA's report on the veterinary services market. Findings regarding horse ownership by US households are presented in this article. Additionally, horse owners' use of and expenditures for veterinary services are discussed.

Horse ownership statistics

Of the 29,535 nationally representative households surveyed, 2.8% (834) indicated that they owned horses at the end of 1987. When this percentage is projected to the total population of US households, the estimated number of horse-owning households at the end of the year was 2.6 million.

The mean number of horses owned per household was 2.6. Further, 8.1% of horse-owning households owned their horses in partnership with others. Since they did not fully own their horses, the average number of horses owned per household was adjusted accordingly.

Given the estimated number of horse-owning households and the mean number of horses per household, the projected population of horses was 6.6 million. However, this estimate does not reflect all horses in the United States. Horses owned by commercial operations and other organizations would not be addressed in a survey of US households. Therefore, the estimate of 6.6 million only represents a portion of the total US horse population.

On a regional basis, horse ownership was highest in the West, where 3.7% of households owned a horse. The West was followed closely by the South, with 3.2% of households reporting horse ownership. In comparison, the North Central and Northeast regions had 2.8% and 1.5% of households owning horses, respectively.

The most common age bracket for horses was 2 to 5 years (33% of horses owned), 28% were >10 years old, 27% were in the 6- to 10-year bracket, and 13% were <2 years old.

Horse owners were likely to own another species of companion animal. Three-fourths of horse owners owned a dog, and two-thirds owned a cat.

Table 1—Statistics of horse ownership by US households in 1983 and 1987

	1983	1987
Percentage of households owning horses	2.8	2.8
Estimated number of US households (millions)	2.4	2.6
Mean number of horses owned per household (millions)*	3.0	2.6
Estimated horse population (millions)	7.0	6.6

*The mean number of horses owned in 1983 was not adjusted for shared ownership of horses. If the adjustment had not been made with the present survey data, the estimated horse population at the end of 1987 would have been 6.8 million.

From a demographic standpoint, horse owners tend to be families with children. Among all US households, for instance, families with children represent 43% of households. Among horse-owning households, however, 63% were families with children. Another important demographic characteristic of horse-owning households is the location of residence. A disproportionately high percentage of horse owners live in small cities. The percentage of horse owners living in areas with a population <50,000 was 60%. In contrast, the percentage of all US households in these areas is only 28%.

Trends in horse ownership

A similar study was conducted for AVMA in 1983, and the estimated number of horses owned by US households was 7 million, according to that research (Table 1).[1] On the basis of the present study, there has been a slight decline in horses owned by households. The main factor in this decrease from 7 million to 6.6 million is the average number of horses owned per household (3.0 vs 2.6).

The estimated horse population is considerably higher than the estimated 1985 horse population (5.3 million) given by the American Horse Council.[2] That estimate included horses owned by US households, as well as those owned by commercial establishments and organizations. However, the survey methods used in the American Horse Council study was oriented toward horse enthusiasts who

---

Prepared by C. Michael Troutman, PhD, Charles, Charles Research Group, Overland Park, Kan. Fourth in a series of 5 synopses from the entire report, which became available Sept 15 (*see* JAVMA, Oct 1, 1988, p 765).

subscribed to selected horse magazines, belonged to national horse clubs, and owned a horse of a registered breed. Such methods would underestimate the horse population because some horse owners might not subscribe to the specific horse magazines or belong to selected horse clubs.

Use of veterinary services

The percentage of owners who obtained veterinary care was 47.4%. Horse owners had their horses examined or treated by a veterinarian an average of 1.85 times. Since the average number of horses owned at any time during 1987 was 2.84 horses per household, the average number of veterinary visits per horse owned was 0.7 (1.85 ÷ 2.84).

Horse-owner expenditures for veterinary services and products were estimated by analyzing a selected group of owners who had a horse examined by a veterinarian. Although some of these owners had dogs and/or cats, they did not report any veterinary visits for their dogs or cats. Therefore, almost all of their expenditures would have been for equine veterinary care.

The mean cost per visit among this group of horse owners was $65.27. Since the average number of equine veterinary visits per horse-owning household was 1.85, the estimated expenditures per household would have been $120.75 (1.85 × $65.27). During 1987, about 3% of US households owned a horse, and projecting the average expenditure per household to all horse-owning households gives an estimated total expenditure for equine care of $329.8 million in 1987.

Over half of horse-owning households did not obtain equine veterinary care in 1987. Those who did not obtain such care may represent an opportunity for increasing horse-owner demand. Therefore, one marketing goal could be to promote the benefits of annual equine veterinary care.

Other sources for equine health care services and products

Horse owners were asked where else they went for "professional health care services, advice, special diets, or medications." Fifty-two percent of horse owners identified feed or farm stores as sources. This percentage reflects the fact that feed and farm stores supply equine dietary management products that may not be available from equine veterinary practices. Farriers were identified by 20% and stables/trainers by 12%. Pet stores were identified by 14%, and this may be because most horse owners had a dog or cat. Breeders were identified by 4%. Thirty-two percent did not use an alternative source. The total exceeded 100% because some horse owners used more than one source.

The basis for the selection of source(s) is not clear, but horse owners may turn to nonveterinary sources more for professional products rather than professional health care services. Equine dietary products and a variety of equine medications are available from these alternative sources, and this might explain why a high percentage of horse owners turn to them.

These sources may represent a competitive challenge to equine practitioners. To that extent, another marketing goal could be to promote the relative advantages of consulting equine practitioners for these products and services.

---

1. Charles, Charles & Associates. The veterinary services market. Schaumburg, Ill; American Veterinary Medical Association, 1983.
2. Peat, Marwick, Mitchell & Co. The economic impact of the US horse industry. Washington, DC: American Horse Council, 1987.

DEC

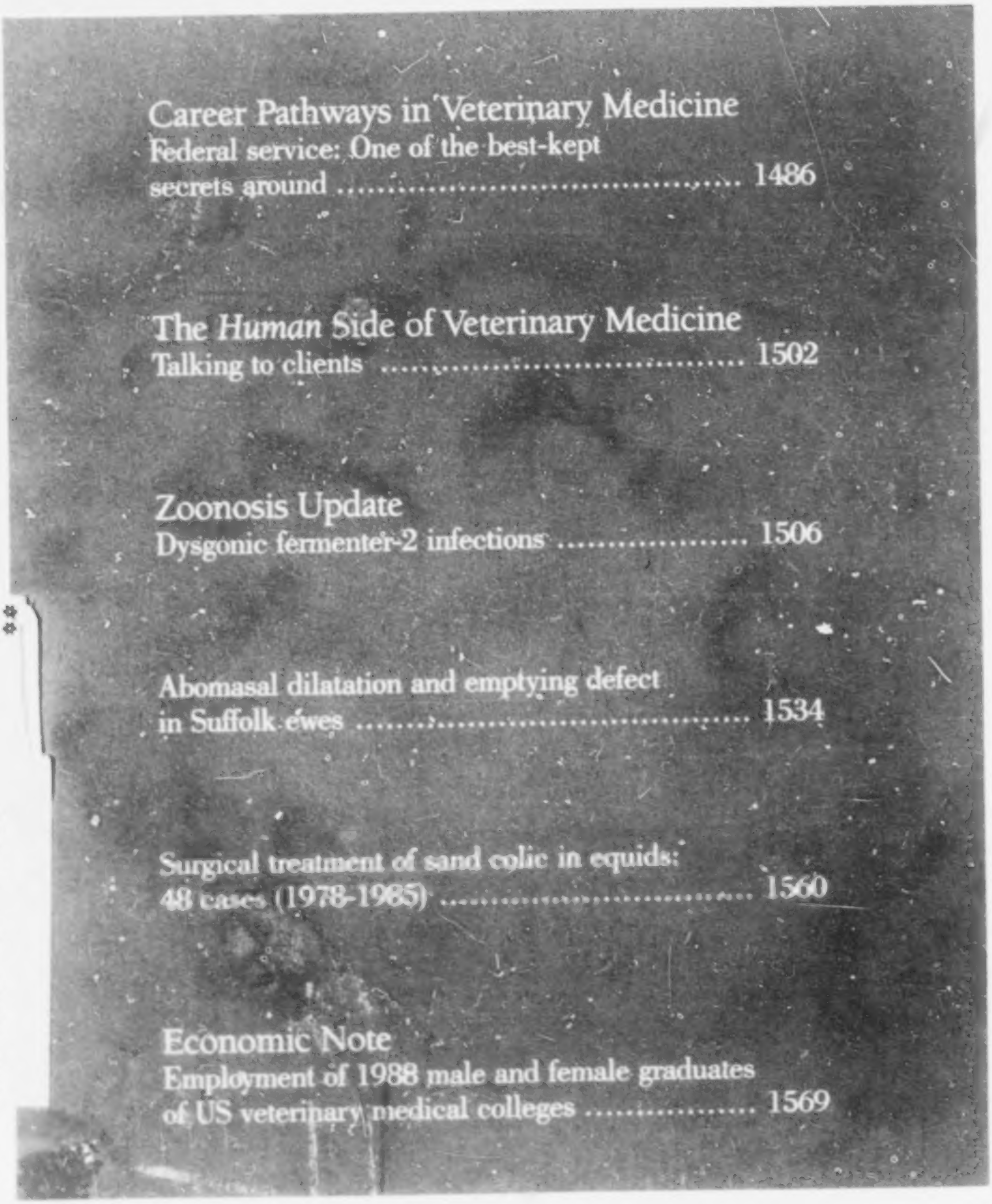
15

1988

A3100-2
1 13189

December 15, 1988, Volume 193, Number 12

JOURNAL OF THE AMERICAN VETERINARY MEDICAL ASSOCIATION



Career Pathways in Veterinary Medicine

Federal service: One of the best-kept secrets around 1486

The *Human* Side of Veterinary Medicine

Talking to clients 1502

Zoonosis Update

Dysgonic fermenter-2 infections 1506

Abomasal dilatation and emptying defect in Suffolk ewes 1534

Surgical treatment of sand colic in equids: 48 cases (1978-1985) 1560

Economic Note

Employment of 1988 male and female graduates of US veterinary medical colleges 1569

8001852662 1 121588 2 23 J
CONGRESSIONAL INFO SERV ##
MR ED KIANKA STAT REF INDEX ##
4520 EAST WEST HWY ##
BETHESDA MD 20814 ##

JOURNAL
OF THE AMERICAN VETERINARY MEDICAL ASSOCIATION

©American Veterinary Medical Association, 1988
All Rights Reserved

Vol 193 December 15, 1988 No. 12
JAVMA 193(12) 1477-1604 (1988)
ISSN 0003-1488

Letters

Benefits of animal research 1480
More on testing for exocrine pancreatic function 1480
Satisfactory vs poor, fair, good, and excellent 1481
Caring about animals—thoughts from a student 1481
Comments on editorial 1482

Editorial

Veterinary prescription drugs—good things do happen—*J. S. Gloyd* 1483

Career Pathways in Veterinary Medicine

Federal service: One of the best-kept secrets around—*Alwynelle S. Ahl* 1486

Veterinary Services Market for Companion Animals

Pet-bird and exotic-pet owners and their use of veterinary services—*C. Michael Troutman* 1490

News

FDA Advisory Committee Characterizes Rx and OTC Drugs 1493
Peace Corps Volunteers on Road to Morocco .. 1494
Poison Hotline Now Toll Free 1495
AVMA's Congressional Fellow Enthusiastic Over Opportunities for Veterinarians in Washington 1496
AVMA Invites Applications for Congressional Fellowship 1497
Veterinary Workshop Featured at AMA Impairment Conference 1498
Deaths 1499

The *Human* Side of Veterinary Medicine

Talking to clients—*Jacob Antelyes* 1502

Zoonosis Update

Dysgonic fermenter-2 infections—*John R. August* 1506

Special Report

Comparison of the general moral reasoning of small animal veterinarians vs large animal veterinarians—*Donnie J. Self, Susan K. Safford, and George C. Shelton* 1509

Interpretive Summaries of Articles in This Issue 1514

Food Animal Economics

Rates of diseases and their associated costs in two Colorado sheep feedlots (1985–1986)—*M. D. Salman, D. A. Dargatz, C. V. Kimberling, J. S. Reif, and G. E. Hopper* ... 1518

Reports of Original Studies

Verapamil administration for acute termination of supraventricular tachycardia in dogs—*Mark Kittleson, Bruce Keene, Paul Pion, and Jerry Woodfield* 1525

Cisplatin for treatment of transitional cell and squamous cell carcinomas in dogs—*Wayne Shapiro, Barbara E. Kitchell, Theresa W. Fossum, C. Guillermo Couto, and Gordon Theilen* 1530

Clinical Reports

Abomasal dilatation and emptying defect in a flock of Suffolk ewes—*Pamela L. Ruegg, Lisle W. George, and Nancy E. East* 1534

Antemortem diagnosis of hepatic adenocarcinoma in a ewe—*J. Lofstedt, S. Schelling, J. Stowater, and E. Morris* 1537

Diagnosis and surgical correction of patent ductus venosus in a calf—*Johanna M. Reimer, William J. Donawick, Virginia B. Reef, Henry R. Wagner, and Thomas J. Divers* 1539

Surgical management of bilateral diaphragmatic paralysis in a dog—*Craig E. Greene, R. Randy Basinger, and Jeff B. Whitfield* 1542

Use of hyperthermia and radiotherapy in treatment of a large mast cell sarcoma in a dog—*Roberto A. Legorreta, David L. Denman, Mary C. Kelley, and G. C. Lewis, Jr.* 1545

Adenocarcinoma of the gland of the third eyelid in seven dogs—*Brian Wilcock and Robert Peiffer, Jr.* 1549

Unsuccessful surgical repair of a short soft palate in a dog—*Michael S. Bauer, Lyndell Levitt, John W. Pharr, J. D. Fowler, and Anthony W. P. Basher* 1551

Carpet deodorizer as a contact allergen in a dog—*Karen M. Comer* 1553

Treatment of flukes in a toucan—*Robert F. Giddings* 1555

Renal adenoma in a cat—*Walter R. Clark and Ronald B. Wilson* 1557

Reports of Retrospective Studies

Surgical treatment of sand colic in equids: 48 cases (1978–1985)—*T. E. Specht and Patrick T. Colahan* 1560

Ultrasonographic features of splenic lymphosarcoma in dogs: 12 cases (1980–1986)—*Robert H. Wrigley, Linda J. Konde, Richard D. Park, and Jack L. Lebel* 1565

Economic Note

Employment of 1988 male and female graduates of US veterinary medical colleges—*J. Karl Wise* 1569

What Is Your Diagnosis?

J. L. Carpenter and H. E. Childers 1571

Book Reviews

Field Guide to Wildlife Diseases. Volume 1. General Field Procedures and Diseases of Migratory Birds 1536

Renal Diseases in Dogs and Cats: Comparative and Clinical Aspects 1564

Abstracts of Selected Reports

Comparison of P_{O_2}, P_{CO_2}, and pH in blood collected from the femoral artery and a cut claw of cats 1548

Efficacy of morantel sustained-released bolus in control of gastrointestinal nematodes of weaned calves during the autumn-winter grazing season 1556

Prognostic index for acute abdominal crisis (colic) in horses 1559

Announcements

Coming Meetings 1573
Foreign Meetings 1576
Educational Opportunities 1577
Applications for Membership 1580

Classified Ads 1583

PUBLICATIONS DIVISION STAFF
Dr. Albert J. Koltveit, *Editor-in-Chief*
Dr. Ann Schola Clark, *Associate Editor*
Dr. Janis H. Audin, *Assistant Editor*
Dr. Nancy W. Leveque, *Assistant Editor*
Dr. Kathleen J. Kovacs, *Assistant Editor*
Bernadine Gordon Clune, *Production Manager*
Kris Piepenburg, *Assistant Production Manager*
Susan Kahler, *News Editor*
Terri Gallatin, *Assistant News Editor*
Charles Hamilton, *Advertising Representative*
Irene Jansons, *Advertising Production Manager*
Opal Anderson, *Advertising Assistant*
Elisabeth Crist, *Editorial Assistant*
Geraldine Ernst, *Editorial Assistant*
Beth Foor, *Editorial Assistant*
Janice Johnson, *Editorial Assistant*
Rhonda Jones, *Editorial Assistant*
Helen Moscicke, *Editorial Assistant*
Leslie Quinlan, *Editorial Assistant*
Robert Reotutar, *Editorial Assistant*
Lea Spencer, *Editorial Assistant*
Nancy Stein, *Advertising Assistant*

AVMA OFFICERS
Dr. Walter L. Martin, Jr., 2223 E 23rd St, Chattanooga, TN 37407, *President*
Dr. Samuel E. Strahm, PO Box 1256, Pawhuska, OK 74056, *President-Elect*
Dr. Jesse D. Derrick, 226 Engram St, PO Box 146, Montezuma, GA 31063, *Vice President*
Dr. Owen R. Stevens, Jr., 99 Portland St, South Berwick, ME 03908, *Treasurer*
Dr. Shelton Pinkerton, 4101 Piedmont Rd, Pensacola, FL 32503, *Chairman of the Executive Board*
Dr. Arthur Freeman, *Executive Vice President*
Dr. Bruce W. Little, *Assistant Executive Vice President*

AVMA SCHAUMBURG OFFICE

American Veterinary Medical Association, 930 N Meacham Rd, Schaumburg, IL 60196. Office hours: 8:30 am to 4:45 pm, Monday through Friday. Telephone toll free: 1-800-248-AVMA (In Illinois: 1-800-233-AVMA). Outside the continental United States call 312-605-8070.

AVMA GOVERNMENTAL RELATIONS DIVISION

Dr. Lawrence E. Miller, 1023 Fifteenth Street, NW, Suite 300, Washington, DC 20005-2602. Telephone: 202-659-2040.

AVMA INSURANCE INFORMATION

To obtain information on the AVMA Group Health and Life Insurance Trust or the AVMA Professional Liability Insurance Trust, call toll free: 1-800-621-6360.

SUBSCRIPTIONS: For one year: members $35, others $70 in the United States and possessions; $90 in foreign countries. Single copies: $6.00 in the United States and possessions, $8.00 in foreign countries.

Published semimonthly at 930 N Meacham Rd, Schaumburg, IL 60196, by the American Veterinary Medical Association. Second class postage paid at Schaumburg, Ill, and at additional mailing offices. Contents copyright 1988 by the AVMA.

ADDRESS CHANGE: Send new address (and moving date) 45 days ahead. Include old address as it appeared on previous issues (if possible send label).

POSTMASTER: Send address changes to JAVMA, 930 N Meacham Rd, Schaumburg, IL 60196.

Veterinary Services Market for Companion Animals

Pet-bird and exotic-pet owners and their use of veterinary services

This is the 5th article in the series of synopses from the AVMA report on the veterinary services market. This article highlights major findings regarding ownership of pet birds, rabbits, and other exotic pets. Additionally, 1987 veterinary service expenditures for these animals are discussed.

Ownership statistics

Pet birds—In the survey of 29,535 households, 5.7% (1,679) owned one or more pet birds on Dec 31, 1987. Most of these households had only 1 bird, although 37% had 2 or more birds. Among bird-owning households, the mean number of birds owned was 2.5. When projected to all US households, the estimated number of pet-bird owners at the end of 1987 was 5.2 million. The projected population of birds owned was 12.9 million.

Pet-bird ownership was highest in the West, where 7.7% of households owned a pet bird. This was partly attributable to California, where almost 9% of households owned a pet bird. The percentage of pet-bird owners in the South was 5.4%. Percentages for the Northeast and North Central regions were 5.2% and 5.0%, respectively.

Demographic profiles of bird-owning households were similar to profiles of dog and cat owners. The similarities are not surprising, because a high percentage of bird owners also owned either a dog or cat. For example, 65% of bird owners owned a dog, and 47% owned a cat.

Other pet species—Survey respondents were asked whether they owned pets other than a dog, cat, or pet bird. Overall, 7.4% (2,186 of 29,535) of households surveyed indicated that they owned another pet species during 1987. On the basis of this percentage, the projected number of US households owning such pets was 6.7 million.

The top "other pet" species owned during 1987 was fish, mentioned by 2.8% of respondents (Table 1). This percentage and the estimated number of fish-owning households likely is an underestimate of the percentage of households owning fish. Some fish owners who were surveyed may not think of them as pets or companion animals; instead, they view their aquarium and fish as ornamental household items. On their questionnaire, these respondents might not have indicated fish as a pet.

Table 1—Percentage and estimated number of US households owning companion animals other than dogs, cats, and birds

Pet species	**US households (%)**	**No. of households owning species (thousands)**
Fish	2.8	2,539
Rabbit	1.7	1.495
Hamster	1.1	990
Guinea pig	0.5	486
Gerbil	0.4	360
Ferret	0.2	189
Mice and other rodents	0.4	369
Turtles	0.4	315
Other reptiles	0.3	279
Other birds	0.5	432
Livestock pets	0.4	396
All others	0.2	189

After fish, rabbits were the most frequently owned, and this was followed by several rodent species including hamsters, guinea pigs, gerbils, and mice. Another small mammal species mentioned was ferrets. As a group, rabbits, rodents, and other small mammals were owned by 4.3% of households. In comparison, turtles and other reptiles were owned by less than 1% of households. A small percentage of households identified pigeons, chickens, and ducks, as well as livestock as pets. The small percentage of exotic pets in the "all others" category included pets such as monkeys, tarantulas, and scorpions.

Households that owned pets such as fish, rabbits, and hamsters were frequently young families with children. For example, 60% of these households were headed by a parent <45 years old, with children in the home. Also, over half of those households had 2 or more children. Therefore, ownership of the other species is highly correlated with the presence of children in the home.

Use of veterinary services

Only 7.6% of bird-owning households obtained

Prepared by C. Michael Troutman, PhD, Charles, Charles Research Group, Overland Park, Kan. Last in a series of 5 synopses from the entire report, which became available Sept 15 (*see* JAVMA, Oct 1, 1988, p 765).

avian veterinary care in 1987. Among those who took their bird to a veterinarian, the average cost per visit was $29.68. Thus, the estimated 1987 veterinary expenditures of pet bird owners was $26.2 million.

Among owners of the other species, 9.9% obtained veterinary care. The average cost per visit for the other pets was $27.64 and, when projected to all US households owning them, the estimated 1987 expenditures for their veterinary care was $45.9 million.

Owners of rabbits, rodents, and ferrets were responsible for 72% of the $45.9 million, or equivalently, $33.1 million. In other words, more was spent on veterinary care for these small mammals than for pet birds. Also, small mammal owners obtained more veterinary care for their pets than did owners of fish, reptiles, or other species. For example, 15% of rabbit owners had their pet examined by a veterinarian. For ferret owners, the percentage who obtained veterinary care was particularly high (41%). As a distinct group, therefore, owners of rabbits, rodents, and ferrets are a significant market for veterinary services.

Conclusions and implications

Although pet birds, rabbits, rodents, and other exotic pets are not as common as dogs and cats, over 10 million US households own these pets. Therefore, they should represent an important market for veterinary services; however, only a small percentage of all these owners obtain annual veterinary care.

One reason is that most of these owners may not have a "regular" veterinarian. For instance, 72% of those whose only pet was a bird, rabbit, or other exotic animal did not have a veterinarian. In contrast, over 80% of dog and cat owners had a veterinarian who they would normally call when their pet needed health care.

Other findings from the survey suggest that some owners will turn to nonveterinary channels for their pet health needs. When asked where besides a veterinarian they went for "professional health care services, advice, special diets or medications," 50% of those whose only pet was a bird or exotic animal mentioned pet stores. Many of those owners may have been buying dietary management products at pet stores; however, they could also be purchasing over-the-counter medications and health care services.

These findings suggest that most pet bird and other exotic-pet owners are unaware of the benefits of routine preventive veterinary care. Therefore, one marketing goal could be to promote the benefits of annual veterinary care for pet birds, rabbits, and pet mammals.

Others who own such pets may think of pet store personnel rather than veterinarians as sources of information and advice on how to address pet health care needs. However, increasing numbers of small animal practitioners are emphasizing the availability of avian services, and this may influence more bird owners to view veterinarians as the most authoritative source for avian health care services/advice. In view of the relative significance of rabbits, rodents, and ferrets as pets, it is equally important for veterinarians to emphasize availability of services for those species.

Economic Note

Employment of 1988 male and female graduates of US veterinary medical colleges

On the basis of the 1988 AVMA survey of 1,472 graduates of US veterinary medical colleges, it was estimated that 75% of the graduates accepted positions as private practice employees at a mean annual salary of $23,079.[1] This report describes in detail the employment choices of 1988 male and female veterinary medical college graduates.

Type of employment

Of the 1,472 graduates responding to the 1988 AVMA survey, 49% were women and 51% were men. Table 1 shows the proportion of graduates receiving offers of employment upon graduation. Excluding graduates entering advanced study programs (graduate degrees, internships, or residencies), 78% of the women received one or more offers of employment, compared with 88% of the men, which is 2 to 3 percentage points lower than reported for 1987 graduates.[2]

Regarding graduates who had accepted employment (62%), 96% of the women and 98% of the men would work full-time, whereas 4% of the women and 2% of the men would work part-time. Of the 28 graduates indicating they would have part-time employment, 18 (64%) were women, and 10 (36%) were men. In comparison with 1987, slightly more women and slightly fewer men accepted full-time positions in 1988.

*Table 1—Employment offers to male and female veterinary medical college graduates, 1988**

	Male (n = 667)	**Female** (n = 609)	**Total** (n = 1,276)
Received ≥ 1 offer	88%	78%	83%
Received no offers	12%	22%	17%

*Excludes graduates entering advanced study programs.

The distribution of female and male graduates was determined according to type of full-time employment (Table 2). Approximately 71% of female graduates accepting full-time employment took positions as employees in private practice, compared with 78% of male graduates. About 20% of the women, compared with 11% of the men, began advanced study programs.

Starting salaries

Graduates were asked to report their starting salary (on an annual basis) for full-time employment. Table 3 shows that the female graduate's mean starting

Table 2—Employment of male and female veterinary medical college graduates, 1988

	Male (n = 504)	**Female** (n = 385)
Large animal exclusive (%)	3.4	—
Large animal predominant (%)	13.1	2.3
Mixed animal (%)	17.9	10.4
Small animal predominant (%)	8.1	10.9
Small animal exclusive (%)	31.5	45.5
Equine predominant (%)	3.8	2.1
University (research or teaching; %)	2.0	2.3
Federal government (%)	—	—
Military service (%)	1.8	0.8
State/local government (%)	0.2	—
Industry/commercial business (%)	0.8	0.5
Advanced study (%)	10.7	20.5
Self-employed (%)	5.4	4.2
Other employment (%)	1.4	0.5

Table 3—Starting salary by type of practice for male and female veterinary medical college graduates, 1988

	Male	**Female**
Large animal exclusive	$24,488 (17)	—
Large animal predominant	$23,236 (65)	$23,055 (9)
Mixed animal	$22,802 (87)	$21,015 (36)
Small animal predominant	$22,682 (39)	$22,518 (41)
Small animal exclusive	$24,095 (153)	$23,053 (163)
Equine predominant	$21,427 (18)	$20,912 (8)
All practice types	$23,396 (379)	$22,616 (257)

Figures in parentheses = No. of graduates reporting full-time employment and starting salary.

Prepared by J. Karl Wise, PhD, Wisemark Associates, PO Box 681189, Schaumburg, IL 60168-1189.

Table 4—Fringe benefits received by male and female full-time employed graduates, 1988

	Male (n = 504)	Female (n = 385)	Total (n = 889)
Life insurance	26%	21%	24%
Medical/hospital plan	62%	62%	62%
Dental plan	11%	8%	10%
Pension plan	9%	5%	7%
Profit-sharing plan	14%	13%	13%
Disability insurance	33%	24%	29%
Liability insurance	57%	53%	55%
Association dues	46%	40%	43%
Continuing education	64%	57%	61%
Annual vacation leave	76%	74%	75%
Sick leave	40%	43%	41%
Housing/apartment	6%	5%	5%

salary as an employee in private practice was $22,616, up 2.7% from 1987. The male graduate's mean starting salary as an employee in private practice was $23,396, up 5.1% from 1987. The 1988 mean starting salary for females was $780 or 3.3% less than the 1988 mean starting salary for males.

In large animal predominant and small animal predominant practices, women and men had nearly identical mean salaries. In other types of private practice, however, men would earn higher salaries, on average, by amounts ranging from about $515 in equine practice to approximately $1,800 in mixed animal practice. The survey did not secure information on each graduate's responsibilities or hours worked in the new job; thus, it is not possible to draw conclusions from these survey data about reasons associated with varying salaries between male and female graduates.

Fringe benefits

All graduates were asked to indicate which of 12 fringe benefits would be provided by their new employer. Of male and female graduates who accepted full-time employment, the percentage receiving each of the fringe benefits is in Table 4. The percentages of men and women receiving fringe benefits were similar. Approximately 62% of women and men would be covered by a medical/hospital plan, at least 74% of women and men would receive annual vacation leave, 57% of women and 64% of men would have employer-paid continuing education expenses, and 53% of women and 57% of men would have employer-provided liability insurance.

Characteristics of graduates

Responding graduates provided information on personal characteristics such as age, marital status, and number of children (Table 5). The mean age of females and males was 27 years. Regarding marital status, 67% of female graduates were single, 28% were married, and 5% were divorced. Of the male graduates, 56% were single, 41% were married, and 3% were divorced. About 6% of the women and 20% of the men had one or more children.

Table 5—Personal characteristics of male and female veterinary medical college graduates, 1988

	Male	Female	Total
Average age (yr)	27	27	27
Marital status			
Single (%)	56	67	61
Married (%)	41	28	35
Divorced (%)	3	5	4
Widowed (%)	—	<1	<1
Graduates with children (%)	20	6	13

References

1. Wise JK. Employment, starting salaries, and educational indebtedness of 1988 graduates of US veterinary medical colleges. *J Am Vet Med Assoc* 1988;193:1317–1318.

2. Wise JK. Employment of 1987 male and female graduates of US veterinary medical colleges. *J Am Vet Med Assoc* 1987;191:1623–1624.

A3101-2
1/24/89

January 15, 1989, Volume 194, Number 2

JOURNAL OF THE AMERICAN VETERINARY MEDICAL ASSOCIATION

3001B5262 1 011589 2 23 J
CONGRESSIONAL INFO SERV ##
MR ED KIANKA STAT REF INDEX ##
4520 EAST WEST HWY ##
BETHESDA MD 20814 ##

Research Roundup—What you need to know about the feline immunodeficiency virus 169

Original studies and clinical reports on feline immunodeficiency virus 213–233
249–257

The *Human* Side of Veterinary Medicine
Listening: Heart and soul of doctor/client relationships 201

Economic Note
Trend in real starting salaries of US veterinary college graduates, 1980–1988 283

3

Hereditary chondrodysplasia in newborn lambs 244

Avian tuberculosis in a horse 260

JOURNAL
OF THE AMERICAN VETERINARY MEDICAL ASSOCIATION

©American Veterinary Medical Association, 1989
All Rights Reserved

Vol 194 January 15, 1989 No. 2
JAVMA 194(2) 161-320 (1989)
ISSN 0003-1488

Letters

Questions conclusion in retrospective study 164
Comments on "Reflections" article 165
Do animals have rights? 165
Zoonoses and AIDS in human beings 165
More on exocrine pancreatic insufficiency 165

News

Research Roundup—What you need to know about the feline immunodeficiency virus 169
Regulatory Front—Private enterprise and federal agencies attack sulfamethazine residues 174
Convention Spotlight—AVMA's '89 convention will "Focus on the Future" 176
Practice Management Corner—Five things clients want from you 178
Technicians Today—Animal technology programs reviewed 183
Out and About—Delta Society explores interdependence of people, animals, and environment 184
Rabies Compendium 188
Deaths 192

The *Human* Side of Veterinary Medicine

Listening: Heart and soul of doctor/client relationships—*Jacob Antelyes* 205

Interpretive Summaries of Articles in This Issue 209

Reports of Original Studies

Epidemiologic and clinical aspects of feline immunodeficiency virus infection in cats from the continental United States and Canada and possible mode of transmission—*Janet K. Yamamoto, Herman Hansen, Esther W. Ho, Teresa Y. Morishita, Takiko Okuda, Thomas R. Sawa, Robert M. Nakamura, and Niels C. Pedersen* 213

Feline immunodeficiency virus infection in cats of Japan—*Takuo Ishida, Tsukimi Washizu, Kazushige Toriyabe, Shigekatsu Motoyoshi, Isamu Tomoda, and Niels C. Pedersen* 221

Seroepidemiologic survey of feline immunodeficiency virus infection in cats of Wake County, North Carolina—*C. B. Grindem, W. T. Corbett, B. E. Ammerman, and M. T. Tomkins* 226

Epidemiologic observations on feline immunodeficiency virus and *Toxoplasma gondii* coinfection in cats in Baltimore, Md—*C. J. Witt, T. R. Moench, A. M. Gittelsohn, B. D. Bishop, and J. E. Childs* 229

Serologic response of domestic ferrets (*Mustela putorius furo*) to canine distemper and rabies virus vaccines—*John P. Hoover, Charles A. Baldwin, and Charles E. Rupprecht* 234

Use of farrowing rate as a measure of fertility of boars—*L. Kirk Clark, Allan P. Schinckel, Wayne L. Singleton, Mark E. Einstein, and Robert F. Teclaw* 239

Radiographic diagnosis of hereditary chondrodysplasia in newborn lambs—*Jerome A. Vanek, Patricia A. Walter, and A. D. Alstad* 244

Clinical Reports

Feline leukemia virus and feline immunodeficiency virus infections in a cat with lymphoma—*Grady H. Shelton, Kenneth D. McKim, Pennie L. Cooley, Paul F. Dice, Robert G. Russell, and Chris K. Grant* 249

Chronic leukopenia associated with feline immunodeficiency virus infection in a cat—*Grady H. Shelton, Janis L. Abkowitz, Michael L. Linenberger, Robert G. Russell, and Chris K. Grant* 253

Demodicosis in two cats seropositive for feline immunodeficiency virus—*Stephanie Chalmers, Robert O. Schick, and James Jeffers* 256

Keratoconjunctivitis sicca associated with fracture of the stylohyoid bone in a horse—*Shauna L. Spurlock, Gareth H. Spurlock, and Michael Wise* 258

Diagnosis of avian tuberculosis in a horse by use of liver biopsy—*Jeanne Lofstedt and Richard M. Jakowski* 260

Campylobacteriosis in an aborted equine fetus—*C. B. Hong and James M. Donahue* 263

Monorchidism in three colts—*Elizabeth M. Santschi, James S. Juzwiak, and Donnie E. Slone* 265

Sperm granuloma in a stallion—J. P. Held, P. Prater, R. L. Toal, J. T. Blackford, and M. McCracken 267

Hyperinsulinism and hypoglycemia associated with pancreatic islet cell tumor in a ferret—*Albert E. Jergens and Daniel P. Shaw* 269

Treatment of a calf with *Clostridium chauvoei* infection—*Kenneth E. Hall* 272

Reports of Retrospective Studies

Idiopathic gonitis in heifers: 34 cases (1976–1986)—*John B. Madison, Eric P. Tulleners, Normand G. Ducharme, Bruce L. Hull, D. Michael Rings, and Frank H. Welker* 273

Ultrasonography as a diagnostic aid in horses with anaerobic bacterial pleuropneumonia and/or pulmonary abscessation: 27 cases (1984–1986)—*Johanna M. Reimer, Virginia B. Reef, and Pamela A. Spencer* 278

Economic Note

Trend in real starting salaries of US veterinary medical college graduates, 1980–1988—*J. Karl Wise* 283

What Is Your Diagnosis?

Rene T. van Ee, Robert R. Selcer, Robert Toal, and Mike Walker 285

Book Reviews

A History of Veterinary Ophthalmology 238

Abstracts of Selected Reports

Bioassay techniques and high-performance liquid chromatography for detection of oxytetracycline residues in tissues from calves 243

Effect of vaccination with a pentavalent leptospiral vaccine on *Leptospira interrogans* serovar *hardjo* type hardjo-bovis infection of pregnant cattle 248

Clinical evaluation of transmissible gastroenteritis vaccines and vaccination procedures for inducing lactogenic immunity in sows 268

Effect of sodium bicarbonate infusions on ionized calcium and total calcium concentrations in serum of clinically normal cats 271

Serum relaxin and progesterone concentrations in pregnant, pseudopregnant, and ovariectomized, progestin-treated, pregnant bitches: Detection of relaxin as a marker of pregnancy 282

Announcements

Coming Meetings 288
Foreign Meetings 291
Certification Examinations 292
State Board Examinations 292
Educational Opportunities 295
Applications for Membership 296

Classified Ads 300

PUBLICATIONS DIVISION STAFF

Dr. Albert J. Koltveit, *Editor-in-Chief*
Dr. Ann Schola Clark, *Associate Editor*
Dr. Janis H. Audin, *Associate Editor*
Dr. Nancy W. Leveque, *Assistant Editor*
Dr. Kathleen J. Kovacs, *Assistant Editor*
Bernadine Gordon Clune, *Production Manager*
Kris Piepenburg, *Assistant Production Manager*
Susan Kahler, *News Editor*
Terri Gallatin, *Assistant News Editor*
Charles Hamilton, *Advertising Representative*
Irene Jansons, *Advertising Production Manager*
Opal Anderson, *Advertising Assistant*
Elisabeth Crist, *Editorial Assistant*
Geraldine Ernst, *Editorial Assistant*
Beth Foor, *Editorial Assistant*
Janice Johnson, *Editorial Assistant*
Rhonda Jones, *Editorial Assistant*
Helen Moscicke, *Editorial Assistant*
Leslie Quinlan, *Editorial Assistant*
Robert Reotutar, *Editorial Assistant*
Lea Spencer, *Editorial Assistant*
Nancy Stein, *Advertising Assistant*

AVMA OFFICERS

Dr. Walter L. Martin, Jr., 2223 E 23rd St, Chattanooga, TN 37407, *President*

Dr. Samuel E. Strahm, PO Box 1256, Pawhuska, OK 74056, *President-Elect*

Dr. Jesse D. Derrick, 226 Engram St, PO Box 146, Montezuma, GA 31063, *Vice President*

Dr. Owen R. Stevens, Jr., 99 Portland St, South Berwick, ME 03908, *Treasurer*

Dr. Shelton Pinkerton, 4101 Piedmont Rd, Pensacola, FL 32503, *Chairman of the Executive Board*

Dr. Arthur Freeman, *Executive Vice President*

Dr. Bruce W. Little, *Assistant Executive Vice President*

AVMA SCHAUMBURG OFFICE

American Veterinary Medical Association, 930 N Meacham Rd, Schaumburg, IL 60196. Office hours: 8:30 am to 4:45 pm, Monday through Friday. Telephone toll free: 1-800-248-AVMA (In Illinois: 1-800-233-AVMA). Outside the continental United States call 312-605-8070.

AVMA GOVERNMENTAL RELATIONS DIVISION

Dr. William R. Van Dresser, 1023 Fifteenth Street, NW, Suite 300, Washington, DC 20005-2602. Telephone: 202-659-2040.

AVMA INSURANCE INFORMATION

To obtain information on the AVMA Group Health and Life Insurance Trust or the AVMA Professional Liability Insurance Trust, call toll free: 1-800-621-6360.

SUBSCRIPTIONS: For one year: members $35; others $70 in the United States and possessions; $90 in foreign countries. Single copies: $6.00 in the United States and possessions; $8.00 in foreign countries.

Published semimonthly at 930 N Meacham Rd, Schaumburg, IL 60196, by the American Veterinary Medical Association. Second class postage paid at Schaumburg, Ill, and at additional mailing offices. Contents copyright 1989 by the AVMA.

ADDRESS CHANGE: Send new address (and moving date) 45 days ahead. Include old address as it appeared on previous issues (if possible send label).

POSTMASTER: Send address changes to JAVMA, 930 N Meacham Rd, Schaumburg, IL 60196.

BPA

Epidemiologic and clinical aspects of feline immunodeficiency virus infection in cats from the continental United States and Canada and possible mode of transmission

Janet K. Yamamoto, PhD; Herman Hansen, DVM; Esther W. Ho, BS; Teresa Y. Morishita, MS; Takiko Okuda, MS, DVM; Thomas R. Sawa, DVM, PhD; Robert M. Nakamura, DVM, PhD; Niels C. Pedersen, DVM, PhD

Summary: *The epidemiologic features of feline immunodeficiency virus (FIV) infection were evaluated in 2,765 cats from the United States and Canada. Of these cats, 2,254 were considered by veterinarians to be at high risk for the infection, and 511 were healthy cats considered to be at low or unknown risk. Of the cats in the high-risk group, 318 (14%) were found to be infected with FIV. The infection rate among low- or unknown-risk cats was 6 of 511 (1.2%). Male cats in the high-risk group were 3 times more likely to be infected than were females, similarly as were cats >6 years old, compared with younger cats; domestic cats, compared with purebred cats; and free-roaming cats, compared with confined cats. Feline immunodeficiency virus and FeLV infections did not appear to be linked with each other; 16% of FeLV-infected cats in the high- and low-risk groups were coinfected with FIV. In contrast, there was a pronounced linkage between FIV and feline syncytium-forming virus (FeSFV) infections. Seventy-four percent of FeSFV-infected cats in the high-risk study group were coinfected with FIV, compared with a 38% FIV infection rate among cats that were not infected with FeSFV.*

The major clinical manifestations associated with FIV infection in cats that were surveyed included chronic oral cavity infections (56%), chronic upper respiratory tract disease (34%), chronic enteritis (19%), and chronic conjunctivitis (11%). Bacterial infections of the urinary tract (cystitis), skin, and ears were seen in a small proportion of cats. Fever of unspecified origin, anorexia, weight loss, lethargy, vomiting, abnormal behavioral problems, lymphosarcoma, and myeloproliferative disorders were seen as accompanying or primary features of the disease in a proportion of affected cats. Anemia and leukopenia were observed in about a third of the cats that were clinically ill at the time of testing.

Experimental studies indicated that biting was a highly efficient mode of transmission. Cats with clinical signs of illness tended to shed more virus in their saliva than did healthy carrier cats. Seroepidemiologic studies also supported the notion that territorial aggression and biting were important natural modes of FIV transmission.

A group of 18 human beings who had intimate contact with FIV-infected cats were found to be seronegative for the virus. There was no positive evidence that FIV was of public health importance.

In 1986, a T-lymphotropic lentivirus initially was isolated from a group of cats with an acquired immunodeficiency syndrome-like disease.[1] An identical virus was detected in cats from Japan[2] and the United Kingdom[3] and was described in 1988. In the years since the discovery of the virus, diagnostic tests have been developed to detect the infection, and veterinarians throughout the world have begun to test an increasing number of cats.

The causative agent of this newly recognized disease syndrome is a lentivirus that is morphologically and biochemically similar to human immunodeficiency virus, but is antigenically distinct.[1] The virus originally was named feline T-lymphotropic lentivirus, which was descriptive of a major feature of the virus, ie, growth in T lymphocytes, and alluded to the taxonomy of the agent. Now that it is clearly established that the virus is a major cause of a chronic acquired immunodeficiency-like syndrome in cats, the virus has been renamed feline immunodeficiency virus (FIV).[4] This name reflects its taxonomic and pathogenic relationship to human and simian immunodeficiency viruses (HIV, SIV). The names HIV, SIV, and FIV are in accordance with the nomenclature selected for this type of virus by an international committee.[5]

Animal inoculation studies have identified the primary stage of infection.[1,6] Within 4 to 6 weeks of inoculation, infected cats developed transient fever, leukopenia, and neutropenia lasting several weeks.

From the Department of Medicine, School of Veterinary Medicine, University of California, Davis, CA 95616 (Yamamoto, Ho, Morishita, Okuda, Pedersen), Veterinary Laboratory Branch, State of Hawaii, Department of Agriculture, Division of Animal Industry, 99-762 Moanalua Rd, Area, HI 96701 (Sawa), Department of Animal Science, University of Hawaii-Manoa, Honolulu, HI, 96822 (Nakamura), and Hansen's Veterinary Immunology, 450 Porter, Ste C, Dixon, CA 95620 (Hansen).

This study was supported in part by NIAID-1-RO1-AI25802-01, Public Health Services grants CA-39016, Save Our Cats and Kittens (SOCK) Inc, the Winn Foundation, Cat Fanciers Association, and the Ralston-Purina Corporation.

This phase of the infection was associated with generalized lymphadenopathy that lasted many months before subsiding. At the present time, however, none of the specific pathogen-free (SPF) cats that were infected with the virus have entered the terminal phase of illness.[6] The virus appears to be transmitted with great difficulty by intimate contact alone.[6] In utero and neonatal (lactogenic) infections also have not been observed under experimental conditions.[6] The virus is transmitted readily by parenteral inoculation of blood and plasma, and is detected in high concentration in saliva.[6] Bites were postulated as one possible mode of transmission.[6]

Other than initial descriptions of the naturally acquired disease,[1-3] there is little information concerning the spectrum of illnesses that can be associated with FIV infection. The predominant disease syndrome consists of chronic infections of the mouth (periodontitis, stomatitis), nasal passages, conjunctiva, ears, skin, and intestinal tract. This immunodeficiency-like syndrome progressively worsens over months or years. Behavioral abnormalities, apparently associated with CNS involvement, have been observed in some infected cats.[1,3] Hematologic abnormalities, usually leukopenia and anemia, have been seen in a proportion of infected cats.[1,3,6] A myeloproliferative disorder developed in one cat with experimentally induced FIV infection.[1,6]

The epidemiologic features of FIV infection in cats have not been well studied. The virus is virtually worldwide in distribution,[1-3] but risk groups have not been identified. There is a suggestion, however, that free-roaming (indoor/outdoor, stray, feral) cats are at higher risk, and that bringing cats together from such environments may lead to localized epizootics.[1]

The public health hazards of FIV have been minimized on the basis of preliminary reports.[1] The virus is antigenically distinct from HIV, and several human beings in prolonged and intimate contact with infected cats did not have serologic evidence of FIV infection.[1] The high species-specificity of various lentivirus isolates also has tended to assure the public that cats are not a source of human disease. Nevertheless, more serologic studies in this area remain to be done.

The study reported here was derived from a large seroepidemiologic survey of 2,765 cats in North America. Of these cats, 2,254 had clinical signs of disease or exposure history suspicious enough to lead veterinarians to request testing, and 511 were healthy-appearing cats considered to be at low risk. In all, 324 of 2,765 cats were found to be infected.

This study is concerned mainly with data collected from these cats. The information included age, gender, major clinical signs of disease, hematologic abnormalities, and incidence of exposure to 2 other retrovirus infections of cats (feline syncytium-forming virus [FeSFV] and FeLV). Experimental studies pertaining to the likely mode of transmission of the virus in nature, risk groups, and lack of cat-to-human transmission also were evaluated.

Materials and methods

Serologic survey—A serologic survey of 2,254 domestic cats from a high-risk group of cats in the continental United States and Canada was performed. The cats of this group had clinical signs of disease that were typical of those described for FIV-infected cats in a diseased cattery[1] or that were in contact with such infected cats. An additional group of sera was obtained from 511 cats considered to be at low or unknown risk for FIV infection. Cats of the low- or unknown-risk group were pets and were from the continental United States and Canada (n = 352), were feral from the campus of the University of California at Davis (n = 77),[a] or were from the Yolo County pound or San Francisco Society for the Prevention of Cruelty to Animals shelter (n = 82).[a] Veterinarians submitted serum samples (1 to 2 ml) along with negligible to detailed clinical and hematologic histories. The collected sera were tested for FIV antibodies by indirect fluorescent antibody (IFA) assay or by immunoblot analysis. A portion of the collected sera also was tested at random for FeLV by ELISA for FeLV-p27 antigen and for FeSFV antibodies[7] by IFA assay on FeSFV-infected *Felis catus* whole fetus-4 cells (Fcwf-4).[8]

Indirect fluorescent antibody assay for FIV antibodies—Sera were tested for FIV antibodies by IFA assay, using FIV-infected blood lymphocytes or infected Crandell feline kidney cells as substrates.[1,6] The sera were tested at a dilution of 1:10 in phosphate-buffered saline solution (PBSS). Fifteen microliters of diluted sera was placed on individual wells of acetone-fixed IFA slides of FIV-infected cells, which were incubated for 30 minutes at 37 C in a moist chamber. The slides were washed 3 times in PBSS and then were incubated for an additional 30 minutes at 37 C with fluorescein-conjugated rabbit anti-cat IgG.[b] After washing, the slides were counterstained with 0.01% Evans blue, mounted in 50% glycerol in PBSS, and read by use of a fluorescent microscope. The serum samples were considered positive for FIV antibodies when giant cells and infected cells had typical membrane and cytoplasmic fluorescence. Positive and negative control sera were included in every assay. For further confirmation of test sensitivity, samples of IFA-positive and IFA-negative control sera also were tested at random by immunoblot analysis. Any serum that was inconclusively positive by IFA was automatically retested by immunoblot analysis.

---

[a] Serum samples were obtained from these cats as part of a feral cat neutering and disease control study conducted on the campus of the University of California at Davis. The project leaders were Drs. Julie Levy and Kathy James.

[b] Antibodies Inc, Davis, Calif.

Immunoblot analysis—The virus from FIV-infected cell culture fluid was clarified by low-speed centrifugation, concentrated by ultracentrifugation, and purified by passage over a 10%/50% (w/v) continuous sucrose gradient.[1] Virus purified by this procedure was electrophoretically transblotted onto nitrocellulose paper as the substrate for the immunoblots.[1,6] Serum samples were diluted 1:50 in buffer 3 (0.15*M* sodium chloride, 0.001*M* edetic acid, 0.05*M* Tris base, 0.05% Tween 20, and 0.1% bovine serum albumin) and were incubated with virus blot strips in separate glass tubes for 12 hours at 37 C. The blot strips were washed individually and incubated for 1 hour at 37 C with peroxidase-conjugated rabbit anti-cat IgG[c] for cat serum and peroxidase-conjugated rabbit anti-human IgG[c] for human serum. After extensive washing, each strip was incubated with a fresh substrate solution (0.05% diaminobenzidine and 0.01% H_2O_2 in 0.1*M* Tris, pH 7.4) for 4 to 10 minutes at 20 C. The reaction was stopped by addition of excess distilled H_2O when visible bands had been established, and the strips were blot-dried. The molecular weight of each band on the immunoblots then was determined by comparing the migration distance of the molecular standards on the strip previously stained with amido black. Positive and negative control sera were included in each immunoblot analysis as internal controls for diagnostic evaluation.

Isolation of FIV from infected lymphocytes and saliva—Blood mononuclear cells (BMC) obtained from SPF cats were purified by ficoll-diatrizoate sodium gradient centrifugation,[9] and were stimulated with 5 µg of concanavalin A/ml for 3 days in a 5% CO_2 incubator at 37 C. The cells were washed with Hanks balanced salt solution, resuspended in RPMI 1640 culture medium at a final concentration of 0.5 to 1×10^6 cells/ml, and placed in 25-cm^2 culture flasks. These uninfected, stimulated BMC were cocultivated at 1:1 with infected BMC prepared by the same method, or cultured with 0.2 to 0.5 ml of saliva. Culture media consisted of RPMI 1640, 10% heat-inactivated fetal bovine serum, 10 mM HEPES, penicillin (100 U/ml), streptomycin (10 µg/ml), gentamicin (50 µg/ml), 2 mM L-glutamine, $5 \times 10^{-5}M$ 2-mercaptoethanol, polybrene (2 µg/ml), and recombinant human interleukin-2[d] (2,100 U/ml). Cultures were incubated in 5% CO_2 at 37 C and monitored every other day for giant cell formation and cell death. Culture supernatants were harvested for assay for reverse transcriptase (RT) activity, and the cells were resuspended in fresh culture medium on every third day or twice a week. These cultures were further supplemented with stimulated cells from the uninfected BMC stock to maintain a minimal cell concentration of 0.5 to 1.0×10^6 cells/ml. The culture was considered negative for virus infection and was terminated on day 42 of the culture period when the culture indicated lack of RT activity, and cells were IFA-negative when exposed to FIV-positive serum. The RT assay used poly(rA)-oligo(dT_{12-18}) as template primer, 5 µCi[^3H]-labeled thymidine triphosphate/sample, and Mg^{2+} as divalent cation for detecting FIV.[1,6,10] The culture fluids also were tested for FeLV-p27 by results of ELISA.[7] The cells were tested for FeSFV infection by IFA; positive control antiserum was produced by inoculating SPF cats with FeSFV.[8]

Experimentally induced FIV infection—In earlier studies,[1,6] 8- to 16-week-old SPF kittens had been inoculated IV or intraperitoneally (IP) with 1 to 2 ml of FIV inoculum; kittens 2428 and 2429 had been inoculated IV with infected whole blood or plasma, respectively. For this study, kitten 2841 was inoculated IP with infected cell culture fluid with RT activity of 70,000 counts per minute (cpm)/ml. Kittens J13, J14, and J15 were given multiple inoculations (once a week for 3 weeks) of 1 ml of pelleted virus (FIV isolate from No. 2429), with RT activity of 500,000 cpm/ml. Kitten J13 was inoculated IV, whereas the others were inoculated IP. Kittens were monitored daily for overt clinical signs and weekly by physical examination.[6] Saliva and blood lymphocytes from experimentally infected kittens were tested for FIV isolation. At the time of blood or saliva sample collection, kittens 2428 and 2429 (3 months after infection) had generalized lymphadenopathy, and kittens J13, J14, and J15 (8 months after infection) lacked clinical signs of disease. Blood and saliva samples were obtained from kitten 2841 at the time of death (2 months after infection). This kitten was suffering from pancytopenia and anemia and had a myeloproliferative disorder.[6]

Naturally infected cats—Cats with naturally acquired FIV infection were adults (with clinical signs of disease) that ranged in age from 2 to 6 years. Cats were obtained from areas around Honolulu, Hawaii. Cat CJ1 was a domestic shorthair male with ulcerative plasmacytic stomatitis, gingivitis, periodontitis, and hypersalivation. Cat CJ2 was a domestic longhair female with chronic otitis externa, generalized lymphadenopathy, and no sign of oral disease. Cat CJ3 was a domestic shorthair male with severe gingivitis. Cat CJ4 was a domestic shorthair male with gingivitis, ulcerative plasmacytic stomatitis, periodontal disease, hypersalivation, and chronic ear infections.

Experimental bite study—Two of the cats with naturally acquired FIV infection (No. CJ1 and CJ2) and with clinical signs of the immunodeficiency phase of infection were selected for the study. These cats had high concentration of FIV in their saliva. Four SPF kittens, 16 to 20 weeks old (No. 3326, 3327, 3334, and 3340), were used as bite recipients. Kittens 3326 and 3340 were exposed to cat CJ2, and kittens 3327 and 3334 were exposed to cat

---

[c] Cappel Laboratories, Cochranville, Pa.

[d] Cetus Corp, Emeryville, Calif.

CJ1. All 6 cats were anesthetized briefly by use of IV administered ketamine and acepromazine. Opposing sites on the medial and lateral aspects of the caudad thigh were shaved, surgically washed, and disinfected with organic iodide. The mouth of the anesthetized donor cat was opened, and the corresponding upper and lower canine teeth were positioned over the surgically prepared area on the bite recipient. The mouth was manually closed, forcing the opposing canine teeth to penetrate the skin and underlying musculature. The bite-recipient kittens then were treated with penicillin for 3 days to prevent development of abscesses at the bite sites.

Statistical methods—The *P* value was derived by testing the difference between 2 rates in a 2-sample Z test.[11] The difference in the 2 rates was considered to be significant when the *P* value was <0.05 (Z value >1.96 at $\alpha = 0.025$) at a 95% confidence interval.

Public health studies—Sera from 18 human beings with substantial accidental exposure to FIV or FIV-infected cats were selected for this study. Sera were from practicing veterinarians, cat owners, and professional or technical research staff working with the virus or virus-infected cats in a natural or experimental setting. Sera were tested by immunoblotting for antibodies to gradient-purified FIV as described previously.

Results

Feline immunodeficiency virus serologic survey—The serologic survey of domestic cats in the United States and Canada for FIV antibodies involved 2,254 cats with a medical history of chronic infectious diseases or prolonged and intimate contact with such cats (high-risk group) and 511 healthy-appearing cats with no known exposure to FIV (low-risk group). Approximately 14% (310/2,212) of the high-risk group of cats surveyed in the continental United States and 19% (8/42) of those surveyed in Canada were seropositive for FIV antibodies (Table 1). The 14% (318/2,254) infection rate among high-risk cats from the continental United States and Canada was significantly ($P \leq 0.001$) greater than the 1.2% (6/511) infection rate in cats at low or unknown risk (Table 2).

In the high-risk group, there were 663 females, 855 males, and 736 cats without gender description. Of the 1,518 high-risk, FIV-positive cats with gender description, 51 females and 168 males were seropositive for FIV. Thus, more males than females were infected at a ratio of 3.3:1 (Table 1). Because the male-to-female ratio in the entire high-risk group of cats was 1.3:1 (855:663), the difference was significant ($P \leq 0.001$). The predominance of FIV-infected males in the high-risk group also was significant ($P = 0.024$), compared with the male-to-female ratio of 0.97:1 among cats at low risk.

Table 1—Serosurvey of domestic cats from high-risk groups in the United States and Canada

Description	Total surveyed	No. of cats seropositive for FIV (%)
Geographic distribution		
United States	2,212	310 (14%)
Canada	42	8 (19%)
Gender distribution		
F	663	51 (8%)
M	855	168 (20%)
Undescribed gender	736	99 (13%)
Age distribution (yrs)		
<1	198	7 (4%)
1 to 5	678	70 (10%)
6 to 10	390	94 (24%)
11 to 15	205	49 (24%)
>15	19	3 (16%)
Unspecified age	764	35 (12%)
Breed distribution		
Domestic shorthair	449	76 (17%)
Domestic longhair	128	19 (15%)
Siamese	71	4 (6%)
Persian	40	0 (0%)
Himalayan	18	0 (0%)
Burmese	10	0 (0%)
Abyssinian	9	0 (0%)
Main Coon	7	0 (0%)
Others	16	1 (6%)
Unspecified breed	1,506	218 (14%)
Environmental status		
Indoor (owned)	61	5 (8%)
Outdoor (owned)	33	11 (33%)
Indoor/outdoor (owned)	90	18 (20%)
Outdoor (unowned)	28	7 (25%)
Unspecified	2,042	277 (14%)

Table 2—Serosurvey of domestic cats from groups at low risk for feline immunodeficiency virus infection (FIV) in the continental United States and Canada

Vital statistics	Total	FIV infected	FeLV infected	FIV and FeLV infected
Gender distribution				
F	254	0	0	0
M	247	5	5	1
Undescribed gender	10	0	0	0
Age distribution (yr)				
<1	86	0	0	0
1 to 5	157	0	0	0
6 to 10	54	1	0	0
11 to 15	15	1	0	0
>15	2	0	0	0
Adults (age unknown)	197	3	5	1
Breed distribution				
Domestic	473	5	5	1
Purebred	38	0	0	0
Ownership status				
Abandoned, feral, stray	159	3	5	1
Owned	352	2	0	0

Cats kept strictly indoors had a significantly ($P \leq 0.0026$) lower incidence of FIV infection than did cats that were kept strictly outdoors (Table 1). This trend also was evident when the incidence of FIV infection in outdoor/indoor and outdoor cats was compared with the incidence of infection in cats that were not allowed outside access, but the difference was not quite significant at the 95% confidence interval. The incidence of FIV infection in the high-risk group of cats was significantly ($P \leq 0.001$) higher in domestic than in purebred

Table 3—Coinfection of cats with feline immunodeficiency virus (FIV), FeLV, and feline syncytium-forming virus (FeSFV)

Test description and status	No. of cats tested	No. of cats that were FIV-positive (%)
FeLV-27 antigenemia		
Positive	215	34 (16%)
Negative	1,394	226 (16%)
FeSFV antibody status*		
Positive	116	86 (74%)
Negative	88	33 (38%)

*The presence of antibodies to FeSFV in the serum is correlated completely with persistent infection.[8]

*Table 4—Hematologic abnormalities in feline immunodeficiency virus (FIV)-positive cats**

	Normal ranges	Total surveyed	No. of cats (%)	
			Low	High
PCV (%)	24 to 45	40	12 (30%)	2 (5%)
RBC (10^6 cells/μl)	5 to 10	36	15 (42%)	0
WBC (10^3 cells/μl)	5.5 to 19.5	47	14 (30%)	7 (15%)
Lymphocytes (10^3 cells/μl)	1.5 to 7.0	34	18 (53%)	2 (6%)
Neutrophils (10^3 cells/μl)	2.5 to 12.5	37	8 (22%)	13 (35%)
Platelets (10^3 cells/μl)	300 to 800	25	4 (16%)	1 (4%)

*Only one cat in this survey was seropositive for FeLV

*Table 5—Clinical signs of disease in feline immunodeficiency virus (FIV)-positive pet cats**

Description	No. of cats (%)
No. of FIV-positive cats with a disease history	193
Oral signs	
Chronic gingivitis	62 (32%)
Chronic periodontal disease	22 (11%)
Chronic stomatitis	15 (8%)
Ulcerations of tonsils and tongue	10 (5%)
Gastrointestinal tract signs	
Chronic diarrhea (enteritis)	34 (18%)
Others (unspecified)	3 (2%)
Respiratory tract diseases	
Chronic rhinitis	45 (23%)
Upper respiratory tract infections (unspecified)	18 (9%)
Others	2 (1%)
Miscellaneous signs	
Weight loss	43 (22%)
Fever	32 (17%)
Anorexia	33 (17%)
Lymphadenopathy	22 (11%)
Chronic conjunctivitis	21 (11%)
Chronic abscess	20 (10%)
Chronic infection	17 (9%)
Dermatitis	15 (8%)
Lethargy	15 (8%)
Vomiting	16 (8%)
Recurrent cystitis	9 (5%)
Neoplasia (lymphosarcoma [n = 3], myeloproliferative diseases [n = 2], mammary tumor [n = 1])	6 (3%)
Otitis	4 (2%)
Abnormal behavior (CNS involvement)	2 (1%)

*Only one cat in this survey was seropositive for FeLV.

cats. Although purebreds made up 22.9% (171/748) of the cats (with breed specified) in the high-risk population, only 3% (5/171) were FIV-infected. Infected cats of the high-risk group were significantly older than cats of the population as a whole; 23.8% (146/614) of cats ≥6 years old were infected with FIV, compared with an 8.8% (77/876) infection rate in cats <6 years old ($P \leq 0.001$).

Among the 215 cats of the high-risk group that were seropositive for FeLV-p27 antigen, 34 (16%) also were infected with FIV (Table 3). Similarly, 16% (226/1,394) of the FeLV-seronegative cats of the same risk group also were infected with FIV. Similar percentages were observed for coinfections (FIV and FeLV) in cats of the low- or unknown-risk group (Table 2). Thus, there appeared to be no significant linkage between FeLV and FIV infections in the 2 population groups that were studied. In contrast, 74% (86/116) of FeSFV-infected cats were coinfected with FIV. This was significantly ($P \leq 0.001$) higher than the 38% (33/88) incidence of FIV infection among FeSFV-negative cats of the same cohort.

Hematologic survey of FIV-positive cats—Participation in the hematologic survey was sparse, and the hematologic status of the cats described in this study was only from the time of initial FIV testing (Table 4). Only one cat (with clinical signs of disease) in this portion of the survey was coinfected with FeLV. Decreased PCV (30%), decreased RBC count (42%), and leukopenia (30%) were frequently observed in FIV-infected cats that had clinical signs of disease. Leukopenia was associated with lymphopenia (53%) and neutropenia (22%). Cats with leukocytosis (15%) usually had neutrophilia (35%). Mild thrombocytopenia was observed in 16% of the FIV-infected cats with clinical signs of disease, but none had thrombocyte count $< 10^5$ platelets/μl.

Clinical manifestations of FIV infection—In the high-risk group, only 193 FIV-seropositive cats had adequate clinical history. Of these, 56% had signs referrable to the oral cavity, 34% to the respiratory tract, and 20% to the gastrointestinal tract (Table 5). Oral disease usually was manifested by variable degrees of gingivitis, periodontitis, and stomatitis. Many of these cats responded initially to supportive treatment, but with time, they became refractory to treatment. The oral disease often progressed to a stage requiring tooth extraction. The cats then became anorectic and often succumbed to a wasting syndrome. Gastrointestinal tract signs included chronic diarrhea, dehydration, and emaciation. A high mortality also was observed in cats with signs of chronic gastrointestinal tract disease. Upper respiratory tract disease consisted of chronic rhinitis with or without conjunctivitis. Nonspecific signs such as fever, anorexia, weight loss, and lethargy were common in cats infected with FIV. Other clinical signs observed in FIV-infected cats were lymphadenopathy, chronic abscesses, and chronic microbial infections of the skin and ears. Anemia often was observed in the terminal stages of the disease.

Feline immunodeficiency virus isolation from blood and saliva—The concentration of virus in BMC and saliva (Table 6) was measured in the 6 experimentally infected kittens (No. 2428, 2429, 2841, J13, J14, J15) and in 4 cats with naturally acquired infection (No. CJ1, CJ2, CJ3, CJ4). Virus concentra-

Table 6—Feline immunodeficiency virus (FIV) isolation from blood lymphocytes (BL) and saliva of FIV-infected cats

Cat No.	Days after infection	Virus source	Disease status	Reverse transcriptase expression in cell cultures infected with BL or saliva (10^3 cpm/ml)*								
				Days after incubation								
				3	6	9	12	15	18	21	30	45
Experimentally infected												
2428	90	BL;	Healthy	3	3	0.6	0.2	2	0.5	0.5	0.4	8
		saliva		0	0	0.7	0	0.4	0	0	0	0.3
2429	90	BL;	Healthy	0	0	11	56	11	24	13	124	13
		saliva		2	4	0.4	1	0.7	1	0.3	1	32
2841	60	BL;	ill	8	3	3	2	13	68	31	50	ND
		saliva		ND	11	54	35	22	116	70	ND	ND
J13	240	BL;	Healthy	2	1	37	131	181	360	232	ND	ND
		saliva		1	7	83	285	217	235	314	294	300
J14	240	BL;	Healthy	0	2	28	200	178	244	243	ND	ND
		saliva		0	0.9	1	0.4	0.8	3	2	2	0.2
J15	240	BL;	Healthy	0.5	5	98	249	275	302	237	ND	ND
		saliva		0	4	38	211	145	148	189	185	236
Naturally infected												
CJ1	...	BL;	ill	2	1	5	42	127	119	109	94	62
		saliva		2	2	8	8	129	221	267	373	49
CJ2	...	BL;	ill	5	34	85	395	310	468	389	233	76
		saliva		2	3	8	8	108	168	341	430	59
CJ3	...	BL;	ill	0.9	5	83	333	228	185	179	99	123
		saliva		2	3	25	79	407	274	328	387	139
CJ4	...	BL;	ill	3	7	35	182	194	329	209	182	73
		saliva		2	3	3	127	311	328	331	439	284

*The time after incubation when reverse trascriptase appears, and its concentration, are proportional to the amount of virus in the initial inoculum. A large amount of virus in the initial inoculum will lead to a rapid appearance and high reverse transcriptase activity, whereas a small amount of virus will have the opposite effect.

cpm = counts per minute; ND = not determined.

Table 7—Serosurvey of human beings exposed to feline immunodeficiency virus (FIV) or FIV-infected cats

Human being No.	Occupation	Type of exposure	Duration of exposure or time since last exposure	FIV antibody status (by immunoblot analysis)
1	Veterinarian	Owner of FIV-positive cat	2 yr	Negative
2	Veterinarian	Needle stick with infected blood	8 mo later	Negative
3	Veterinarian	Cat bites from FIV-infected cats	1 yr later	Negative
4	Cat owner	Close contact with FIV-positive cat	4 yr	Negative
5	Cat owner	Close contact with FIV-positive cat	4 yr	Negative
6	Cat owner	Close contact with FIV-positive cat	4 yr	Negative
7	Cat owner	Close contact with FIV-positive cat	2 yr	Negative
8	Cat owner	Close contact with FIV-positive cat	1 yr	Negative
9	Cat owner	Close contact with FIV-positive cat	Not stated	Negative
10	Animal handler	Close contact with FIV-positive cat	1 yr	Negative
11	Animal handler	Close contact with FIV-positive cat	7 mo	Negative
12	Animal handler	Close contact with FIV-positive cat	4 mo	Negative
13	Animal handler	Close contact, scratched, bitten	1.5 yr	Negative
14	Researcher	Close contact with infected culture fluids	1 yr	Negative
15	Researcher	Close contact with infected culture fluids	1.5 yr	Negative
16	Researcher	Needle stick with concentrated virus	1.5 yr later	Negative
17	Researcher	Close contact with infected culture fluids	6 mo	Negative
18	Researcher	Contaminated skin wound with infected blood	6 mo later	Negative

tions in the blood and saliva of experimentally infected cats were low during the early stages of infection, but tended to increase after 6 months. Although blood and salivary concentrations of virus tended to be similar, 1 experimentally infected cat (No. CJ14) had low virus concentration in saliva and high virus concentration in blood. There was some correlation between virus concentration in the saliva and health status; 2 of 5 healthy kittens had high concentration of salivary virus, compared with 5 of 5 unhealthy cats (one was a kitten).

Experimental bite study—Seroepidemiologic evidence suggested that biting may be an important mode of FIV transmission. Two of the kittens (No. 3326 and 3327) that were subjected to the bites of cats CJ1 and CJ2 seroconverted to FIV within 37 days, and the remaining kittens (No. 3334 and 3340) seroconverted after 60 days. Virus was successfully reisolated from the blood of all 4 kittens at the time of seroconversion.

Cat-to-human transmission—Human beings (n = 18) that were exposed to FIV, in some instances by relatively high risk occurrences, were uniformly seronegative for FIV when tested by immunoblot analysis (Table 7).

Discussion

The rate of FIV infection among high-risk cats was 14% in the United States and 19% in Canada. These figures are less than half the infection rate for cats in Japan.[12] Possible reasons for these differences have been discussed.[12] The incidence of FIV infection among clinically ill high-risk cats was significantly higher than the incidence of the infection in healthy low-risk cats. The same relationship between FIV infection and illness also has been observed in other studies[12] and suggests that FIV is pathogenic to cats. Seroepidemiologic observations are important, because the immunodeficiency phase of natural FIV infection has not been experimentally re-created; experimentally infected SPF cats kept in pathogen-free environments developed only a transient primary illness and a sustained carrier state (without clinical signs of disease).[6] The FIV infection rate among clinically ill cats also was somewhat lower than the 30% FeLV infection rate reported in similar groups of chronically ill cats more than a decade ago.[13-15]

The clinical phase of FIV infection was seen most often in cats between 6 and 15 years old, although cats in the age range between <1 year and >15 years old sometimes were also affected. The greater age of FIV-infected cats was in contrast to FeLV-infected cats, which tend to become infected at a rapid rate from kittenhood onward.[16] The older age of the cats at the time of disease development suggests either than infection with FIV develops at a much slower rate than for FeLV or that there is a longer period between initial infection and disease manifestation. The latter scenario is supported by results of experimental inoculation studies.[6] Male cats were apt to be infected with FIV at nearly 3 times the expected rate. Cats that were kept strictly indoors were at the lowest risk, and cats that were kept only outdoors were at the highest risk. The typical cat with FIV-related disease, therefore, was most likely to be >6 years old, male, and free-roaming.

The FIV-infected cats usually were domestic type. Infection of purebred cats was uncommon, and probably was attributable to environmental factors and not to genetic predisposition. Purebred cats were more likely to be kept strictly indoors, which would remove one major risk factor for infection.

The major clinical features of the immunodeficiency-like phase of naturally acquired FIV infection were rather stereotyped and essentially the same as those described for FIV-infected cats in Japan.[2,12] Oral cavity disease, including chronic gingivitis, periodontitis, stomatitis, tonsillitis, and glossitis were seen in 56% of the FIV-infected cats. Gastrointestinal tract disease, usually chronic enteritis or enterocolitis, was seen in 20% of the affected cats. Infections of the upper respiratory tract were seen in more than a third of the cats; however, abnormal CNS signs were seen in only 1%. This latter figure may be low because of the way practitioners selected cats for testing. Central nervous system signs of disease usually were of cortical origin; vague behavioral changes, dementia, changes in excretion/elimination habits, rage, and abnormal movements of the facial musculature have been the most common clinical manifestations in cats of this and other studies.[1,2] Neoplasia, usually lymphosarcoma or myeloproliferative disorders, were seen in 3% of the cats. Lymphosarcoma associated with FIV infection also has been reported in a Japanese study,[12] and 1 kitten that was experimentally infected with FIV developed a myeloproliferative disorder.[6] The number of cats with upper respiratory tract, oral cavity, and gastrointestinal tract diseases reflected the predominance of these disorders in this study population, but the actual proportion of cats with these disorders may be skewed. Original descriptions of cats with naturally acquired FIV infection emphasized such signs, and practitioners obviously were concentrating on cats with such signs of disease for testing. The breadth of diseases associated with FIV infection remains to be elucidated.

Several types of hematologic disorders were seen in FIV-infected cats. Forty-two percent of affected cats were anemic to some degree, and 30% were leukopenic. The leukopenia was associated with neutropenia (22%) and/or lymphopenia (53%). The pathogenesis of the anemia and leukopenia has not been determined.

To gain information about possible modes of FIV infection, 2 other retrovirus infections of cats, FeSFV and FeLV, also were evaluated in the same population. Feline leukemia virus infection is spread by intimate contact between persistently viremic and susceptible cats.[15] The virus is shed in urine, saliva, and feces and is transmitted by ingestion and biting. Outside the cat's body, FeLV is quickly inactivated, so prolonged and intimate contact between infected and noninfected cats is required for efficient transmission. Thus, FeLV infection can become rampant in enclosed multiple cat households and catteries. These types of environments provide the intimate contact that is essential for transmission, and virtually all susceptible cats will become FeLV-infected within 1 to 18 months.[17,18] Given the essential differences in FeLV and FIV transmission, it was not surprising that the 2 infections appeared to be transmitted independently of each other.

In contrast to FeLV and FIV infections, FeSFV and FIV infections often developed together. This finding again was not surprising; FeSFV and FIV infections share many common features. Both viruses are inefficiently transmitted by contact alone,[6,8] and FeSFV, like FIV, can be efficiently spread by bites.[8] As seen in the SPF kittens of this study, a single artificially administered bite can transmit FIV in most instances. The same experiment has been done for FeSFV.[6] The single difference in the apparent modes of transmission for these 2 viruses is that FeSFV infection is commonly transmitted in utero, but FIV is not.[6,8]

Almost all FIV-seropositive cats have isolatable virus in their blood, and most of these shed appreciable amounts of virus in their saliva. Therefore, all FIV-seropositive cats should be considered infectious. On the basis of the 10 cats reported herein, it appears that clinically ill cats shed more virus in their saliva than do healthy ones. It follows that ill FIV-infected cats would be more infectious than would their healthy counterparts.

Epidemiologic evidence further supported the role of cat bites in FIV transmission. Males are almost 3 times more likely to be infected than are females. Male cats are more territorially aggressive than are females and have a disproportionate incidence of cat bite wounds and abscesses. Further, cats that are kept strictly indoors, even in groups, do not usually resort to physical aggression. Given the steady transmission of FIV in nature, distinct epidemiologic risk factors (males, free-roaming), efficiency of experimental bite transmission, and the inefficiency of nontraumatic contact, lactogenic, and in utero transmission,[6] it is reasonable to assume that bites may be the major mode of transmission in nature.

Cats infected with FIV live in close contact with human beings. There is some concern, therefore, about the public health importance of this virus. The fact that FIV is found throughout the world suggests that, in cats, the virus greatly predates the modern human epidemic of acquired immune deficiency syndrome. The cat virus, although morphologically and biochemically similar to HIV, is antigenically distinct.[1,6] Until the virus is genetically sequenced, however, its position in the evolutionary tree of lentiviruses is unknown. A small number of human beings that have had close contact with infected cats have been tested for antibodies to the virus; in no instance were any such antibodies found. Lentiviruses are found in many species of animals, and there appears to be a great deal of species specificity. The human virus, HIV, appears most closely related to SIV.

References

1. Pedersen NC, Ho E, Brown ML, et al. Isolation of a T-lymphotropic virus from domestic cats with an immunodeficiency-like syndrome. *Science* 1987;235:790–793.

2. Ishida T, Washizu T, Toriyabe K, et al. Detection of feline T-lymphotropic lentivirus (FTLV) infection in Japanese domestic cats. *Jpn J Vet Sci* 1988;50:39–44.

3. Harbour DA, Williams PD, Gruffydd-Jones TJ, et al. Isolation of a T-lymphotropic lentivirus from a persistently leucopenic domestic cat. *Vet Rec* 1988;122:84-86.

4. Yamamoto JK, Pedersen NC, Ho EW, et al. Feline immunodeficiency syndrome—a comparison between feline immunodeficiency virus and feline leukemia virus. *Leukemia* 1988;in press.

5. Coffin J, Hasse A, Levy JA, et al. Human immunodeficiency virus. *Science* 1986;232:697.

6. Yamamoto JK, Sparger E, Ho EW, et al. Pathogenesis of experimentally induced feline immunodeficiency virus infection in cats. *Am J Vet Res* 1988;49:1246-1258.

7. Lutz H, Pedersen NC, Durbin R, et al. Monoclonal antibodies to three epitopic regions of feline leukemia virus p27 and their use in enzyme-linked immunosorbent assay of p27. *J Immunol Methods* 1983;56:209-220.

8. Pedersen NC. Feline syncytium-forming virus infection. In: Holzworth J, ed. *Diseases of the cat*. Philadelphia: WB Saunders Co, 1986;268–272.

9. Boyum A. Isolation of mononuclear cells and granulocytes from human blood. *Scand J Clin Lab Invest* 1968;97:77-88.

10. Rey MA, Spire B, Dormont D, et al. Characterization of the RNA dependent DNA polymerase of a new human T-lymphotropic retrovirus (lymphadenopathy associated virus). *Biochem Biophys Res Commun* 1984;121:112–133.

11. Brown BW Jr, Hollander M. *Statistics: a biomedical introduction*. New York: John Wiley and Sons Inc, 1977;173–181.

12. Ishida T, Washizu T, Toriyabe K, et al. Feline immunodeficiency virus infection in cats of Japan. *J Am Vet Med Assoc* 1988;194:221–225.

13. Hardy WD Jr. Feline leukemia virus non-neoplastic disease. *J Am Anim Hosp Assoc* 1981;17:941–949.

14. Cotter SM, Hardy WD Jr, Essex M. Association of feline leukemia virus with lymphosarcoma and other disorders in the cat. *J Am Vet Med Assoc* 1975;166:449–454.

15. Hardy WD Jr, Old LJ, Hess PW, et al. Horizontal transmission of feline leukemia virus in cats. *Nature* 1973;244:266–269.

16. Rogerson P, Jarrett W, Mackey L. Epidemiological studies of feline leukemia virus infection. I. Serologic survey of urban cats. *Int J Cancer* 1975;15:781–787.

17. Pedersen NC, Theilen G, Keane MA, et al. Studies of naturally transmitted feline leukemia virus infection. *Am J Vet Res* 1977;38:1523–1531.

18. Grant CK, Essex M, Worley MB, et al. Natural feline leukemia virus infection and the immune response of cats of different ages. *Cancer Res* 1980;40:823–829.

Feline immunodeficiency virus infection in cats of Japan

Takuo Ishida, DVM, PhD; Tsukimi Washizu, MS, DVM; Kazushige Toriyabe, MS, DVM;
Shigekatsu Motoyoshi, DVM, PhD; Isamu Tomoda, DVM; Niels C. Pedersen, DVM, PhD

Summary: *A seroepidemiologic survey for feline immunodeficiency virus (FIV) infection was conducted in Japan. Between June and December 1987, individual sera (n = 3,323) were submitted by veterinary practitioners from many parts of the country. Specimens were from 1,739 cats with clinical signs suggestive of FIV infection and from 1,584 healthy-appearing cats seen by the same practitioners. The overall FIV infection rate among cats in Japan was 960/3,323 cats (28.9%). The infection rate was more than 3 times higher in the clinically ill cats, compared with that in the healthy cats of the same cohort (43.9 vs 12.4%). Male cats were 1.5 times as likely to be infected as were females. Almost all FIV-infected cats were domestic cats (as opposed to purebred cats).*

Complete clinical history was available for 700 of 960 FIV-infected cats. Of these 700 FIV-infected cats, 626 (89.4%) were clinically ill, and the remainder did not have clinical signs of disease. The mean age at the time of FIV diagnosis for the 700 cats was 5.2 years, with younger mean age for males (4.9 years) than for females (5.8 years). Most of the infected cats (94.7%) were either allowed to run outdoors or had lived outdoors before being brought into homes. The mortality for FIV-infected cats during the 6 months after diagnosis was 14.7%, and the mean age at the time of death was 5.7 years.

Concurrent FeLV infection was seen in 12.4% of the FIV-infected cats, but this was not much different from the historical incidence of FeLV infection in similar groups of cats not infected with FIV. Dually infected cats were of a younger mean age than were cats infected only with FIV (4.3 vs 5.2 years). Cats coinfected with FIV and FeLV tended to die at a younger age than did cats infected only with FIV (4.6 vs 5.7 years). There was no obvious relationship between FIV infection rate and antibody titer interpreted as positive for infection with feline infectious peritonitis virus, and feline infectious periotonitis among FIV-infected cats was less than historically expected for the population as a whole.

The clinical signs seen most frequently in FIV-infected cats were stomatitis/gingivitis (52.4%), chronic upper respiratory tract disease (28.9%), anemia (17.9%), emaciation (14.6%), bacterial infections (14.4%), chronic skin disease (13.4%), and chronic enteritis (11.9%). Less frequently observed clinical findings were renal disease, fever of unknown origin, lymphadenopathy, and leukopenia. A small number of FIV-positive cats had infections caused by opportunistic organisms. These diseases included haemobartonellosis, notoedric mange, toxoplasmosis, cryptococcosis, Pseudomonas infection, candidiasis, and atypical mycobacterial infections. Three young FIV-infected cats had FeLV-negative lymphosarcoma or fibrosarcoma.

Feline immunodeficiency virus (FIV) was first described in 1987.[1] The virus originally was called feline T-lymphotropic lentivirus, but the name has been changed to comply with the international nomenclature for lentiviruses that cause acquired immunodeficiency syndrome in man and animals.[2] The feline virus is morphologically and biochemically similar to the human and simian immunodeficiency viruses, but is antigenically distinct.[1] Shortly after the discovery of FIV in the United States, an identical virus was isolated from cats in Japan[3] and the United Kingdom.[4] These latter studies reconfirmed the close relationship between FIV infection and a naturally acquired immunodeficiency-like syndrome in FeLV-negative cats.

The study reported here is an extension of earlier work on FIV infection in Japan,[3] and involved 3,323 cats that were tested during a 6-month period between June and December of 1987. Information gained from this extended survey revealed the magnitude and clinical expression of FIV infection in cats of Japan. It also supported previous studies that link FIV infection with a number of chronic infectious disease syndromes of cats.

Materials and methods

Source of sera—Japanese veterinarians were encouraged to submit sera from cats with signs of chronic infections and sera from healthy-appearing

---

From the Departments of Clinical Pathology (Ishida, Washizu, Toriyabe) and Medicine (Motoyoshi, Tomoda), School of Veterinary Medicine, Nippon Veterinary and Zootechnical College, 1-7-1 Kyonan-cho, Musashino-shi, Tokyo 180, Japan, and the Department of Medicine, School of Veterinary Medicine, University of California, Davis, CA 95616 (Pedersen).

The authors thank Cetus Corporation, Emeryville, Calif, for providing the human rIL-2 used in this study.

cats living in the same households or treated by the same practitioners. Sera (n = 3,323) were submitted for testing during the period between June and December of 1987. Of 960 FIV-positive cats, 700 with reasonably complete clinical history were selected for further review.

Antibody assays—Antibody assays for FIV were conducted by the Department of Clinical Pathology, Nippon Veterinary Zootechnical College. An indirect fluorescent antibody (IFA) assay was used as a screening test for FIV antibodies. The substrate for the IFA assay was FIV-infected feline T lymphocytes.[1] Blood mononuclear cells were purified from the blood of specific pathogen-free cats by use of sodium diatrizoate[a] density-gradient centrifugation. The cells were cultured in RPMI-1640 medium containing 10% fetal bovine serum and were stimulated with 5μg of concanavalin A[a]/ml. Three days later, the cultures were treated with 100 U of human recombinant interleukin-2[b] (rIL-2)/ml. The resultant T-lymphocyte culture was infected with the Petaluma strain of FIV.[1] Serum samples were tested at a dilution of 1:10, and those that were positive by results of IFA assay were confirmed to be positive by immunoblot analysis, using electrophoresed FIV proteins.[3]

FeLV and feline infectious peritonitis virus (FIPV) assays—The FeLV-p27 antigen in sera was detected by an ELISA that used monoclonal antibodies to this protein.[5,6] Serum antibodies to FIPV also were determined by ELISA.[7]

Virus isolation—Blood lymphocytes from healthy and clinically ill FIV antibody-positive cats were isolated and established as replicating cell lines as previously described.[1] The cultures were maintained by adding fresh cells, rIL-2, and medium at 3- to 10-day intervals. Cultured cells were examined periodically for a characteristic cytopathic effect (CPE).[1] When CPE was evident, the culture fluid was examined for Mg^{++}-dependent reverse transcriptase activity, and pelleted material was tested by immunoblot analysis against FIV-positive human sera.[1]

Statistical methods—To examine the relationship between FIV serostatus and the variables of age, breed, sex, and health and environment statuses, multiway and 2 × 2 tables were generated by use of a computerized statistical program.[8] The relationship of each variable was evaluated, using the Pearson χ^2 test.

Results

Among the 3,323 sera that were tested, 906 (28.9%) were positive for FIV antibody (Table 1). The FIV infection rate was significantly ($\chi^2 = 401.9$; $df = 1$; $P << 0.005$) higher in cats that were clinically ill (764/1,739; 43.9%) than in the healthy cat population (196/1,584; 12.4%). The male to female ratio of 2.3:1 in FIV-infected cats was significantly ($\chi^2 = 56.5$; $df = 1$; $P < 0.005$) greater than the 1.5:1 ratio seen in the group as a whole. Domestic cats were more likely to be infected than were purebred cats (898/2,627 vs 62/696). The predisposition of domestic cats to FIV infection was statistically significant ($\chi^2 = 169.1$; $df = 5$; $P << 0.005$). Cats kept strictly indoors (16/236; 7%) were significantly ($\chi^2 = 79.5$; $df = 3$; $P < 0.005$) less likely to become infected than were cats that were allowed to roam outside (246/657; 37%). There was a significant ($\chi^2 = 394.2$; $df = 4$; $P << 0.005$) increase in the FIV infection rate with age (Table 1). This was most pronounced for the first 10 years of life.

Table 1—Vital statistics of 3,323 cats in Japan that were surveyed for feline immunodeficiency virus (FIV) infection

Vital statistic	Total surveyed	No. seropositive for FIV (%)
Health status		
Healthy	1,584	196 (12)
Clinically ill	1,739	764 (44)
Sex distribution		
F	1,330	288 (22)
M	1,993	672 (34)
Age distribution (years)		
≤1	690	28 (4)
1 to 5	1,871	545 (29)
6 to 10	612	328 (54)
11 to 15	135	45 (33)
≥15	15	7 (47)
Breed distribution		
Domestic	2,627	898 (34)
Siamese	171	30 (18)
Persian	193	16 (8)
Himalayan	260	12 (5)
Abyssinian	36	4 (11)
Others	36	0 (0)
Environmental status		
Indoor (owned)	236	16 (7)
Outdoor (owned)	165	65 (39)
Indoor/outdoor (owned)	437	159 (36)
Outdoor (unowned)	55	22 (40)

Seven hundred FIV-infected cats with reasonably complete clinical history were selected for further study. The vital statistics for this group of 700 cats are given in Table 2. Among 488 FIV-infected male cats, 415 (85%) were sexually intact; 172 of 212 (81.1%) FIV-infected female cats also were unneutered. The incidence of FIV infection in sexually intact vs neutered cats was not significantly different, however, from the proportion of neutered vs unneutered cats in a comparable group of FIV-negative cats; 379 of 450 (84.2%) FIV-negative males and 236 of 300 (78.7%) FIV-negative females were sexually intact. Greater than 95% of the FIV-positive cats were domestic shorthairs. The age of FIV-infected cats at the time of diagnosis ranged from 2 months to 18 years (Fig 1). The mean (± SD) age was 4.9 ± 2.8 years for males and 5.8 ± 3.8 years for females. The overall mean age was 5.2 ± 3.2 years. Almost all (94.7%) FIV-infected cats were

---

[a] Hypaque 1077, Sigma Chemical Co, St Louis, Mo.
[b] rIL-2, Cetus Corp, Emeryville, Calif.

*Table 2—Vital statistic ratios for 700 cats that were naturally infected with feline immunodeficiency virus (FIV)**

Vital statistic	No. of cats (%)	Ratio
Healthy status		
Clinically ill	626 (89)	8:1
Healthy	74 (11)	
Sex distribution		
M	488 (70)	2:1
F	212 (30)	
Neuter status		
Sexually intact	587 (84)	5:1
Neutered	113 (16)	
Breed distribution		
Domestic	666 (95)	19:1
Purebred	34 (5)	
Environmental status		
Outdoor/indoor	663 (95)	19:1
Strictly indoor†	37 (5)	
FeLV serostatus		
Negative	613 (88)	7:1
Positive	87 (12)	

*Over a 6-month period, mortality in this group of FIV-infected cats was 14.7%. Age of cats ranged from 2 months to 18 years, with mean value of 5.2 years; mean age of males and females was 4.9 and 5.8 years, respectively. † Of these 37 cats, 25 lived in multiple-cat households in which indirect contact with other outdoor/indoor cats was possible.

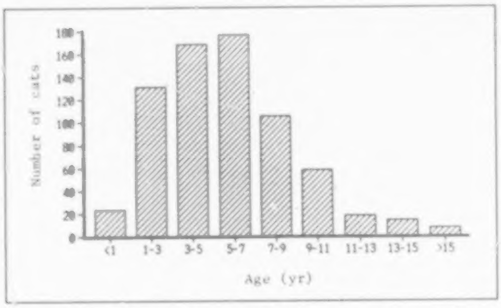


Figure 1—Distribution by age of a select group of FIV-infected cats (n = 700).

either outdoor or indoor/outdoor-roaming at the time of diagnosis, or had been moved strictly indoors from such environments earlier in life. Of the 37 cats that had been kept strictly indoors, 25 lived in multiple-cat households where contact with other outdoor/indoor cats was possible.

Most (626/700) of the FIV-infected cats were clinically ill at the time of diagnosis. The mean age of FIV-infected clinically ill cats (5.3 ± 3.1 years) was somewhat greater than that of healthy FIV-infected cats (4.2 ± 3.2 years). The diseases in the FIV-infected cats were variable in severity and nature. More than half (54.7%) of the 700 FIV-infected cats had multiple clinical signs of disease; the mean number of signs per cat was 1.9 (Fig 2). Table 3 gives the most frequent clinical manifestations of FIV-infected cats. Mild disorders included chronic conjunctivitis, rhinitis, and low-grade fever of unknown origin. Severely ill cats usually had multiple problems such as stomatitis, chronic upper respiratory tract disease, anemia, enteritis, and emaciation. Chronic stomatitis/gingivitis was the most frequent (52.4%) complaint in the 700 cats. This was followed in frequency by chronic upper respiratory tract disease (28.9%), anemia (17.9%), emaciation (14.6%), unspecified bacterial infections (14.1%), chronic skin infections (13.4%), and enteritis (11.9%). Additional but less frequently observed signs included renal disease, fever of unknown origin, lymphadenopathy, and leukopenia.

A number of the 700 FIV-infected cats with clinical history of good health suffered from infections that could be considered opportunistic in nature. These infections included haemobartonellosis (n = 10), chronic bacterial pneumonia (n = 7), generalized notoedric mange (n = 6), feline infectious peritonitis (n = 5), pyothorax (n = 5), toxoplasmosis (n = 3), severe intestinal coccidiosis (n = 3), systemic candidiasis (n = 2), and atypical mycobacteriosis (n = 1). Other FIV-infected cats had less specific clinical diagnoses such as hepatitis (n = 10), ascites (n = 8), or abortion (n = 4). Three FIV-infected cats had lymphosarcoma, and 1 had periosteal fibrosarcoma. Of these latter cats, 3 were between 4 and 5 years old and were sero-negative for FeLV antigen and antibody.

Mortality among FIV-infected cats during the 6-month study was 103 of 700 (14.7%). The mean age at death was 5.7 ± 2.9 and 5.9 ± 4 years in males and females, respectively. Clinical signs of disease frequently associated with fatality were stomatitis (49.5%), anemia (45.6%), emaciation (32%), renal disease (32%), and chronic upper respiratory tract disease (30%).

Concurrent FeLV infection was seen in 87 of 700 (12.4%) FIV-infected cats; most (83.9%) of these

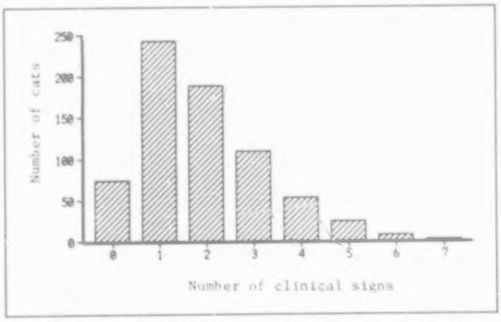


Figure 2—Distribution of FIV-infected cats according to the number of clinical signs at the time of diagnosis (n = 700).

Table 3—Common clinical abnormalities observed in 700 cats infected with feline immunodeficiency virus in Japan

Clinical signs	No. of cats (%)
Stomatitis/gingivitis	367 (52.4)
Chronic upper respiratory tract disease	202 (28.9)
Anemia	125 (17.9)
Emaciation	102 (14.6)
Bacterial infections (undefined)	99 (14.1)
Chronic skin disease (undefined)	94 (13.4)
Chronic diarrhea	83 (11.9)
Renal failure	65 (9.3)
Fever of unknown origin	60 (8.6)
Lymphadenopathy	56 (8.0)
Leukopenia	35 (5.0)

cats were male. The mean age of FeLV-positive, FIV-infected cats was 4.3 ± 2.2 years, compared with 5.3 ± 3.2 years for their FeLV-negative counterparts. Feline leukemia virus infection was seen in 20 of 103 (19.4%) FIV-infected cats that died; dually-infected cats tended to die at a younger mean age than did FeLV-negative FIV-infected cats (4.6 ± 2.4 vs 5.9 ± 3.4 years).

Feline infectious peritonitis titer was determined for 415 of the 700 FIV-infected cats (Fig 3). The mean FIPV antibody titer in these 415 cats was 1:300. The mean antibody titer and titer distribution in the 415 FIV-infected cats was the same as those values in a comparable number of FIV-negative cats that also were tested for FIPV (data not shown). There were 5 cats with confirmed FIP among the 700 FIV-infected cats.

Virus isolation was attempted in 29 clinically ill and 3 healthy FIV antibody-positive cats. All but one lymphocyte culture had CPE beginning 1 to 3 months after culture initiation. The 31 cell cultures that developed CPE were confirmed positive for FIV by results of IFA assay, reverse transcriptase expression, and FIV-p28 antigen detection by immunoblot analysis.

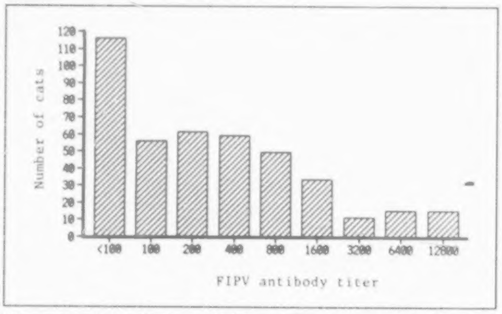


Figure 3—Distribution of feline infectious peritonitis virus (FIPV) antibodies by titer in cats that were naturally infected with FIV (n = 415).

Discussion

The overall FIV infection rate among 3,323 cats that were tested was nearly 30%, which was significantly higher ($P < 0.005$) than the FIV infection rate in a similar study group from the continental United States and Canada.[9] Because the study did not involve cats selected at random, it was not possible to determine the infection rate among cats in Japan at large. The overall infection rate in the general population probably would be lower than the 12.4% incidence that was observed in the healthy cats in the test population of this study. It is unlikely to be as low, however, as the 1.5% infection rate in a group of healthy cats from the United States.[9]

The significantly higher FIV infection rate in cats of Japan, compared with those of the United States and Canada, deserves mention. The cat is a more popular pet in Japan than in North America and the human population density in Japan is far greater. There are more cats per given area in Japan, therefore, than in the United States and Canada. Most pet cats in Japan are kept by people that live in housing with yards; about 95% of pet cats in Japan are allowed to roam free. The number of cats kept by occupants of high-rise tenements is relatively low, compared with that in the United States. Free-roaming has been found to be a high-risk factor for FIV infection in cats of this and other studies.[9] High cat density would further increase the spread of infection, because it would put susceptible and infected cats in greater contact with each other. It also may increase the level of territorial and sexual aggression (biting, scratching) because many more cats would share the same terrain.

Bites have been implicated as a major mode of FIV transmission.[9,10] Biting among cats is usually associated with territorial aggression among freely roaming populations. Biting is a behavior that is observed infrequently among cats that are kept strictly indoors. Biting also has been associated with sexual activity among outdoor cats. If biting and sexual aggression were strongly linked, and if biting were a major mode for FIV transmission, sexually intact cats presumably would have higher incidence of FIV infection than would neutered cats. Sexual intactness did not appear to be a risk factor for cats in Japan, however. The rate of FIV infection was the same in intact and neutered cats. The fact that neutering did not influence the FIV infection rate among cats in Japan also suggested that FIV is not transmitted venereally to any extent.

The mean age of FIV-infected male cats at the time of diagnosis was 4.9 years, which was 1 year younger than the age for females. This suggested that male cats were infected more rapidly than were females. Male cats in Japan were also 1.5 times more likely to be infected than were females. It appears, therefore, that male cats were more likely to engage in activities that put them at increased risk. Male cats are more aggressive than female cats and are more likely to be treated for bite-related disorders (wounds, cellulitis, abscesses) than are females, again suggesting that biting is a major mode of FIV transmission. If FIV were transmitted only by normal nontraumatic contact or by blood-sucking vectors such as fleas, both genders should be at similar risk, and indoor cats also would have a higher infection rate.

The period between infection and the development of the acquired immunodeficiency-like phase of infection was not determined, but it appeared to be long. Clinically ill FIV-infected cats had a mean age that was 1 year greater than that of FIV-infected cats that were healthy, indicating that the period between infection and disease was >1 year. Socializing among cats begins at ages as early as 4 months, and exposure would be expected within the first few years of life. The fact that many clinically ill FIV-infected cats were aged at the time of illness detection suggested that years can pass between the time of infection and illness. This assumption is supported by other studies of naturally and experimentally induced FIV infection in relatively closed populations of cats.[1,9] The mortality among clinically ill FIV-infected cats appeared to be slow in developing. Only 14.7% of the clinically ill cats died within 6 months of diagnosis. This observation also was in agreement with other studies of the naturally acquired disease.[1]

The diseases in clinically ill FIV-infected cats in Japan were virtually identical to those observed in similar groups of cats in the United States.[1,9] Stomatitis, peridontitis, and gingivitis attributable to chronic oral infections were seen in >50% of the cats. In our experience, in Japan, approximately 50% of cats evaluated for chronic oral cavity infections turned out to be FIV infected. Oral infections apparently are sensitive indicators of immunosuppression in cats. Interestingly, oral cavity disease may have an important role in the transmission of FIV. Saliva might contain more virus if the oral lesions are exudative and bleeding, and this might greatly enhance the efficacy of bite-related transmission. This is supported by results of studies of experimentally induced FIV infection.[9,10]

Opportunistic infections were recognized in a few FIV-infected cats. They included haeomobatonellosis, generalized notoedric mange, cryptococcosis, candidiasis, pyothorax, toxoplasmosis, severe intestinal coccidiosis, bacterial pneumonia, *Pseudomonas* infections, and atypical mycobacteriosis. Such infections were considered highly indicative of underlying immunodeficiency, and many of them are included in the diagnosis of acquired immunodeficiency syndrome in human beings.[11,12] In this group of cats, the low incidence of neoplasms that normally are associated with FeLV also was interesting. Two cats with lymphosarcoma and one with fibrosarcoma were relatively young FIV-infected cats with no evidence of either ongoing or previous FeLV infection.

Concurrent FeLV infection was seen in about 12% of FIV-infected cats. This may not be a significant relationship, however, because the overall FeLV infection rate in similar groups of cats in Japan is around 10%.[13] A lack of relationship between FeLV and FIV infections also was seen in a group of cats from the United States and Canada.[9]

The incidence of FIPV antibodies was the same in FIV-infected and FIV-noninfected cats, indicating that coronavirus and FIV infections were not linked. The incidence and titer of FIV antibodies in the group of cats reported herein corresponded with those previously described for cats in Japan.[14] The frequency of clinical feline infectious peritonitis in the cats of this study (5/700 or 0.7%) was smaller than the expected frequency (4.9%) of the disease previously reported in the cat population of Japan.[14]

Mortality in FIV-infected cats during the 6-month study was 14.7%, which was much less than the 54% mortality observed for FeLV-infected cats in Japan during a 14-month period.[13]

References

1. Pedersen NC, Ho EW, Brown ML, et al. Isolation of a T-lymphotropic virus from domestic cats with an immune deficiency-like syndrome. *Science* 1987;235:790–793.

2. Coffin J, Hassee A, Levy JA, et al. Human immunodeficiency virus. *Science* 1986;232:697.

3. Ishida T, Wahsizu T, Toriyabe K, et al. Detection of feline T-lymphotropic lentivirus (FTLV) infection in Japanese domestic cats. *Jpn J Vet Sci* 1988;50:39–44.

4. Harbour DA, Williams PD, Gruffyd-Jones TJ, et al. Isolation of a T-lymphotropic lentivirus from a persistently leucopenic domestic cat. *Vet Rec* 1988;122:84–86.

5. Lutz H, Pedersen NC, Durbin R, et al. Monoclonal antibodies to three epitopic regions of feline leukemia virus p27 and their use in enzyme-linked immunosorbent assay of p27. *J Immunol Methods* 1983;56:209–220.

6. Ishida T, Pedersen NC, Theilen GH. Monoclonal antibodies to the v-fes product and to feline leukemia virus p27 interspecies-specific determinants encoded by feline sarcoma viruses. *Virology* 1986;155:678–687.

7. Ishida T, Washizu T, Fukuoka J, et al. Feline infectious peritonitis virus antibody test using enzyme-linked immunosorbent assay. *Jpn J Vet Sci* 1987;49:145–149.

8. Ryan BF, Joiner BL, Ryan TA Jr. *Minitab handbook*. 2nd ed. Boston: Duxbury Press, 1985;260–275.

9. Yamamoto JK, Hansen H, Ho EW, et al. Epidemiologic and clinical aspects of feline immunodeficiency virus infection in cats from the continental United States and Canada and possible mode of transmission. *J Am Vet Med Assoc* 1989;194:213–220.

10. Yamamoto JK, Sparger E, Ho EW, et al. Pathogenesis of experimentally induced feline immunodeficiency virus infection in cats. *Am J Vet Res* 1988;49:1246–1258.

11. Bigger RJ. Epidemiology of human retroviruses and related clinical conditions. In: Broder S, ed. *AIDS: Modern concepts and therapeutic challenges*. New York: Marcel Dekker Inc, 1987;91–121.

12. Revision of the case definition of acquired immune deficiency syndrome (AIDS) for national reporting—United States. *MMWR* 1985;34:373–375.

13. Ishida T, Kawai S, Fujiware K. Detection of feline leukemia virus infection in Tokyo area by enzyme-linked immunosorbent assay (ELISA). *Jpn J Vet Sci* 1981;43:871–874.

14. Ishida T, Toriyabe K, Fukuoka J, et al. Serodiagnosis of feline infectious peritonitis. In: Lai MC, Stohlman SA, eds. *Coronaviruses*. New York; Plenum Press, 1987;577–578.

Trend in real starting salaries of US veterinary medical college graduates, 1980-1988

Average starting salaries of US veterinary medical graduates have been reported annually since 1980.[1-4] The average starting salary increased 29.1%, from $17,175 in 1980 to $22,181 in 1988 (Table 1). This represents a compounded annual growth rate of 3.2%.

Analysis by type of employer showed that the average starting salary in private practice increased 24.4%, from $18,552 in 1980 to $23,079 in 1988 (Fig 1). In nonprivate practice, the average starting salary increased 43.8%, from $17,967 in 1980 to $25,832 in 1988. The average starting salary for graduates pursuing advanced study increased 31%, from $12,033 to $15,766.

These data show that graduates' starting salaries have risen in money terms. In real terms, ie, correcting for the increased cost of living, graduates' average starting salary declined. The most widely used measure of the change in the cost of living at the retail level is the Consumer Price Index for all urban consumers. The Consumer Price Index increased 43.4% from 1980 to 1988.

Analysis of graduates' starting salaries in real terms was accomplished by expressing the average starting salaries for each type of employer for each year, 1980 through 1988, in 1983 dollars. Table 1 shows average starting salaries in money terms and in real terms (1983 dollars).

Table 1—Real starting salaries of US veterinary medical graduates, 1980–1988

	Money income ($)				Real income (1983 dollars)			
Year	Private practice	Nonprivate practice	Advanced study	All graduates	Private practice	Nonprivate practice	Advanced study	All graduates
1980	18,552	17,967	12,033	17,175	22,433	21,725	14,550	20,768
1981	18,832	18,059	12,937	18,314	20,626	19,780	14,170	20,059
1982	19,351	20,864	13,781	18,700	19,970	21,531	14,222	19,298
1983	19,872	22,865	13,541	19,194	19,872	22,865	13,541	19,194
1984	20,237	21,493	13,797	19,527	19,403	20,607	13,228	18,722
1985	20,956	21,814	14,199	20,164	19,405	20,199	13,148	18,672
1986	21,205	22,027	15,186	20,478	19,275	20,022	13,804	18,615
1987	22,152	25,697	15,272	21,693	19,427	22,536	13,394	19,025
1988	23,079	25,832	15,766	22,181	19,455	21,776	13,291	18,699*

*Based on projected 4.02% increase in cost of living for 1988.

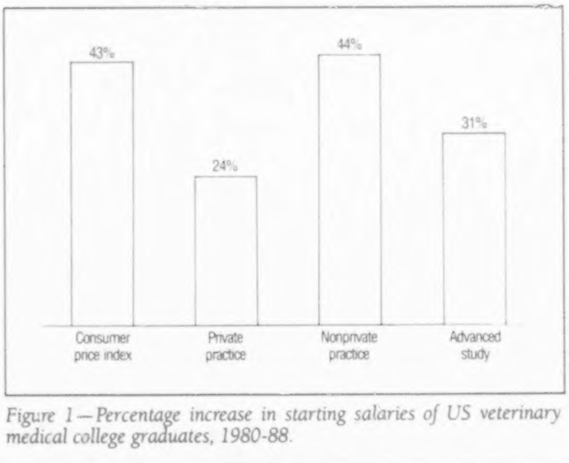


Figure 1—Percentage increase in starting salaries of US veterinary medical college graduates, 1980-88.

Results show that, in real terms, graduates' average starting salary declined from $20,768 in 1980 to $18,699 in 1988, a decrease in purchasing power of 10% over the 8-year period. In private practice, the average real starting salary declined 13.3%, whereas in nonprivate practice, the average real starting salary increased 0.2%, or virtually remained the same. Starting incomes for graduates enrolled in

Prepared by J. Karl Wise, PhD, Wisemark Associates, PO Box 681189, Schaumburg, IL 60168-1189.

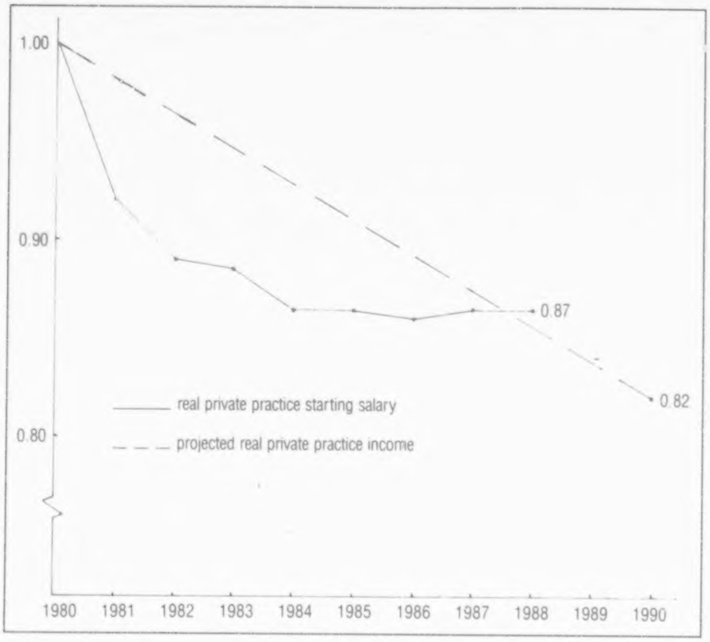


Figure 2—Standardized trend in real starting salaries (1980 = 1.0) in private veterinary practices.

advanced study declined 8.6% in real terms.

On the basis of the 1985 AVMA manpower study, average real private practice net individual income was projected to decline by the year 2000 to 75% of its value in the year 2000.[5–6] Most of the decline was projected to occur by 1990, as it was thought average real private practice income would fall to 82% of its 1980 level by the year 1990. From 1980 to 1990, this represents an 18% decline in projected real income. Intuitively, the impact of the projected decline would be reflected in depressed entry-level salaries, followed by lower overall average real incomes in subsequent years.

Data presented here suggest that, to date, at least for entry-level positions in private practice, the decline in real private practice income has not been as severe as earlier projected. Expressed in standardized form (1980 = 1.0), Figure 2 shows the decline in average real private practice income projected in the 1985 AVMA manpower study. In 1990, it was projected that average real private practice income would be 82% of its 1980 level. For comparison, Figure 1 also shows the decline in average real private practice starting salary. In 1988, the average real starting salary in private practice was 87% of the 1980 average real starting salary. Interestingly, real private practice starting salaries have been flat since 1984, revealing that 1988 graduates have neither gained nor lost purchasing power relative to that for 1984 graduates.

References

1. Wise JK. Real starting salaries of US veterinary medical college graduates, 1978-1985. *J Am Vet Med Assoc* 1986;188:427–428.

2. Wise JK. Employment, starting salaries, and educational indebtedness of 1986 graduates of US veterinary medical colleges. *J Am Vet Med Assoc* 1987;190:209-210.

3. Wise JK. Employment, starting salaries, and educational indebtedness of 1987 graduates of US veterinary medical colleges. *J Am Vet Med Assoc* 1987;191:1489-1490.

4. Wise JK. Employment, starting salaries, and educational indebtedness of 1988 graduates of US veterinary medical colleges. *J Am Vet Med Assoc* 1988;193:1317-1318.

5. Wise JK, Kushman JE. *US veterinary medical manpower study: demand and supply from 1980 to 2000.* Schaumburg, Ill: American Veterinary Medical Association, 1985.

6. Wise JK, Kushman JE. Synopsis of US veterinary medical manpower study: demand and supply from 1980 to 2000. *J Am Vet Med Assoc* 1985;187:358-361.

A3170-2
2/28/89

February 15, 1989, Volume 194, Number 4

JOURNAL

OF THE AMERICAN VETERINARY MEDICAL ASSOCIATION

1988 AVMA Activities Summary 465

Giardiasis—zoonosis or not? 447

Zoonosis Update
Ehrlichiosis 497

Forum
A critical analysis of swine medicine
in American veterinary schools 502

Special Commentary
Skillful writing: A tool for today's
veterinarian 510

Economic Note
1987 incomes of US veterinarians 563

5001852262 1 021589 2 23 J
CONGRESSIONAL INFO SERV **
MR ED KIANKA STAT REF INDEX **
4520 EAST WEST HWY **
BETHESDA MD 20814 **

JOURNAL
OF THE AMERICAN VETERINARY MEDICAL ASSOCIATION

©American Veterinary Medical Association, 1989
All Rights Reserved

Vol 194 February 15, 1989 No. 4
JAVMA 194 (4) 441-608 (1989)
ISSN 0003-1488

Letters

Hopes for sense of charity 446
Profession may lose on ferret issue 446
Regulations for handicapped access 446

News

Research Roundup—Giardiasis—zoonosis or not? 447
Practice Management Corner—Welfare benefits may be taxable 450
AVMA at Work—Council tabulates results of Ninth Symposium "opinionnaire" 452
Serving special-needs clients to be subject of new guidelines 454
Colleges urged to provide dependency awareness instruction 455
Awards and Honors 455
Under the Umbrella—New AAEP president stresses service and communications 456
Washington Watch—Are veterinarians health professionals? 460
Out and About—Reform in swine education contemplated by AASP 461
Student and School News—Tufts celebrates 10th anniversary 462
Veterinary students enlightened with marketing tips 463

1988 AVMA Activities Summary 465

The *Human* Side of Veterinary Medicine

Creative Veterinary Marketing—*Jacob Antelyes* 492

Zoonosis Update

Ehrlichiosis—*Thomas R. Eng and Rosemary Giles* 497

Forum

A critical analysis of swine medicine in American veterinary schools—*Lennart Backstrom* 502

Special Commentary

Skillful writing: A tool for today's veterinarian—*Martha M. Tacker* 510

Interpretive Summaries of Articles in This Issue 512

Reports of Original Studies

Goitrogenic effects in offspring of swine fed sulfadimethoxine and ormetoprin in late gestation—*Timothy E. Blackwell, Ronald E. Werdin, Michael C. Eisenmenger, and Mark A. FitzSimmons* 519

Radiographic evaluation of nonanesthetized and nonsedated dogs for hip dysplasia—*C. S. Farrow and R. T. Back* 524

Clinical Reports

Diffuse alveolar injury in two dogs—*D. C. Cogan and J. L. Carpenter* 527

Anti-triiodothyronine antibodies associated with hypothyroidism and lymphocytic thyroiditis in a dog—*C. B. Chastain, Diane W. Young, and Robert J. Kemppainen* 531

Multiple, resolving, cutaneous histiocytoma in a dog—*William M. Bender, and George H. Muller* 535

Repair of sixth lumbar vertebral fracture-luxations, using transilial pins and plastic spinous-process plates in six dogs—*Daniel D. Lewis, Anita Stampley, Jamie R. Bellah, Gayle S. Donner, and Gary W. Ellison* 538

Dinoseb toxicosis in two dogs—*James D. Fikes, Randall A. Lovell, Michael Metzler, and William B. Buck* 543

Pemphigus foliaceus in two Shetland Sheepdog littermates—*James O. Noxon and Ronald K. Myers* 545

Surgical correction of congenital medial patellar luxation in a llama—*A. J. Kaneps, T. W. Riebold, W. B. Schmotzer, B. J. Watrous, and M. J. Huber* 547

Cutaneous ergotism in a herd of dairy calves—*Robert W. Coppock, Michelle S. Mostrom, Joseph Simon, Donald J. McKenna, Barry Jacobsen, and Henry L. Szlachta* 549

Reports of Retrospective Studies

Mycotic omasitis and rumenitis as sequelae to sepsis in dairy cattle: Six cases (1979–1986)—*R. W. Sweeney, T. J. Divers, D. M. Gillette, and R. H. Whitlock* 552

Aflatoxicosis in Iowa swine: Eight cases (1983–1985)—*W. O. Cook, W. G. Van Alstine, and G. D. Osweiler* 554

Reports on Wildlife and Laboratory Animals

Idiopathic epilepsy in three gaur *(Bos gaurus)—Randall E. Junge, R. Eric Miller, Alexander de Lahunta, Douglas S. Pernikoff, and William J. Boever* 559

Abortion, stillbirth, neonatal death, and nutritional myodegeneration in a rabbit breeding colony—*Behzad Yamini and Susan Stein* 561

Economic Note

1987 incomes of US Veterinarians—*J. Karl Wise* 563

What Is Your Diagnosis?

Anita Stampley 567

Book Reviews

Sheep Husbandry and Diseases 523
Advances in Small Animal Practice 1 542

Abstracts of Selected Reports

Effect of water vapor-saturated air therapy on bronchoalveolar lavage and tracheal mucus transport rate in clinically normal horses 526
Digestion, fecal, and blood variables associated with extensive large colon resection in the horse 530
Influence of dietary source of phosphorus on fecal and urinary excretion of phosphorus and other minerals by male cats 534
Cantharidin toxicosis in horses 537

Announcements

Coming Meetings 557
Foreign Meetings 578
Applications for Membership 579
Certification Examinations 584
State Board Examinations 584
Educational Opportunities 586

Classified Ads 589

PUBLICATIONS DIVISION STAFF

Dr. Albert J. Koltveit, *Editor-in-Chief*
Dr. Ann Schola Clark, *Associate Editor*
Dr. Janis H. Audin, *Associate Editor*
Dr. Nancy W. Leveque, *Assistant Editor*
Dr. Kathleen J. Kovacs, *Assistant Editor*
Bernadine Gordon Clune, *Production Manager*
Kris Piepenburg, *Assistant Production Manager*
Susan Kahler, *News Editor*
Terri Gallatin, *Assistant News Editor*
Charles Hamilton, *Advertising Representative*
Irene Jansons, *Advertising Production Manager*
Opal Anderson, *Advertising Assistant*
Elisabeth Crist, *Editorial Assistant*
Geraldine Ernst, *Editorial Assistant*
Beth Foor, *Editorial Assistant*
Janice Johnson, *Editorial Assistant*
Rhonda Jones, *Editorial Assistant*
Helen Moscicke, *Editorial Assistant*
Leslie Quinlan, *Editorial Assistant*
Robert Reotutar, *Editorial Assistant*
Lea Spencer, *Editorial Assistant*
Nancy Stein, *Advertising Assistant*

AVMA OFFICERS

Dr. Walter L. Martin, Jr., 2223 E 23rd St, Chattanooga, TN 37407, *President*

Dr. Samuel E. Strahm, PO Box 1256, Pawhuska, OK 74056, *President-Elect*

Dr. Jesse D. Derrick, 226 Engram St, PO Box 146, Montezuma, GA 31063, *Vice President*

Dr. Owen R. Stevens, Jr., 99 Portland St, South Berwick, ME 03908, *Treasurer*

Dr. Shelton Pinkerton, 4101 Piedmont Rd, Pensacola, FL 32503, *Chairman of the Executive Board*

Dr. Arthur Freeman, *Executive Vice President*

Dr. Bruce W. Little, *Assistant Executive Vice President*

AVMA SCHAUMBURG OFFICE

American Veterinary Medical Association, 930 N Meacham Rd, Schaumburg, IL 60196. Office hours: 8:30 am to 4:45 pm, Monday through Friday. Telephone toll free: 1-800-248-AVMA (In Illinois: 1-800-233-AVMA). Outside the continental United States call 312-605-8070.

AVMA GOVERNMENTAL RELATIONS DIVISION

Dr. William R. Van Dresser, 1023 Fifteenth Street, NW, Suite 300, Washington, DC 20005-2602. Telephone: 202-659-2040.

AVMA INSURANCE INFORMATION

To obtain information on the AVMA Group Health and Life Insurance Trust or the AVMA Professional Liability Insurance Trust, call toll free: 1-800-621-6360.

SUBSCRIPTIONS: For one year: members $35; others $70 in the United States and possessions; $90 in foreign countries. Single copies: $6.00 in the United States and possessions; $8.00 in foreign countries.

Published semimonthly at 930 N Meacham Rd, Schaumburg, IL 60196, by the American Veterinary Medical Association. Second class postage paid at Schaumburg, Ill, and at additional mailing offices. Contents copyright 1989 by the AVMA.

ADDRESS CHANGE: Send new address (and moving date) 45 days ahead. Include old address as it appeared on previous issues (if possible send label).

POSTMASTER: Send address changes to JAVMA, 930 N Meacham Rd, Schaumburg, IL 60196.

BPA

A critical analysis of swine medicine in American veterinary schools

Lennart Backstrom, DVM, PhD

Currently, the content and direction of curricula and postgraduate training at veterinary schools in the United States are being reviewed, and changes are being discussed on local and national levels.[1,a] Food animal veterinarians probably have more reasons than any other group to welcome and participate in these discussions. Despite their opinion that there is a great need for veterinary services to the changing livestock industry, food animal veterinary practices do not attract as many young veterinarians as they used to. For many years, most veterinary school graduates have turned to companion and sports animal sectors, and veterinary schools have responded by increasing the number of companion animal clinical faculty and by developing increasingly sophisticated clinical facilities and course programs oriented to the care of the individual and companion animal, with less emphasis on flock and herd food animal medicine. Food animal faculty often believe school resources are too limited to adjust curricula to the needs of the livestock industry, but so far there has been no united opinion among them on how to address the issue.

Who is to blame?

Calvin Schwabe recently addressed the current crisis in food animal veterinary medicine by pointing out that of a recent graduating class at the University of California-Davis, only 2 of 128 went into food animal practice in the livestock intensive state of California. "Something is wrong, and we in the academic veterinary medicine today bear substantial blame."[2] In the swine industry, producers often charge veterinarians with a lack of interest and skills. In a nationwide survey, Wise[3] estimated that 43% of the swine producers in the United States never consult veterinarians. A recent editorial in *Pork '88*[4] indicated an increase of swine producer interest in veterinary services, but at the same time many practitioners with considerable interest and expertise in swine medicine report that swine veterinary practice is unrewarding, primarily because producers have little or no interest in their services. The recent "Prudent Drug Use"[5] program, cosponsored by the American Association of Swine Practitioners (AASP) and National Pork Producers Council (NPPC), so far, appears to have elicited little response from swine producers. The program recommends that swine producers establish a client-veterinarian relationship for monitoring and control of drug residues.[6]

If swine medicine is going to survive as a career emphasis, the cause-effect relationship between producers and veterinarians has to be analyzed. The correct conclusions have to be made, by the producers concerning the use of veterinarians, and by the veterinary schools concerning the quantity and quality of the undergraduate and veterinary school curriculum and the postgraduate training in swine medicine.

Influences on choice of professional field

It is assumed that veterinary students choose their professional field on the basis of a combination of factors, including interest, availability of faculty, courses and other school resources related to various fields of veterinary medicine, the quality of education, educational costs, and job opportunities.

During veterinary school, some students maintain a strong determination to pursue a certain type of career, but many change their minds under the influence of the curriculum and opportunities for specialty training. Thus, the direction and content of courses offered can have a decisive impact on a student's eventual field of choice. A diversified core curriculum might initiate interest in fields not previously considered by the student, whereas a dominance of certain disciplines or animal species might lead to greater depth of knowledge in those areas at the expense of diversity.

When evaluating students' choices of career, educational costs also have to be addressed. It is not surprising that recent graduates, many with accumulated debts of $50,000 or more after 8 years of college studies, are likely to go into the area for which they have been best trained and will be best

---

From the Department of Medical Sciences, School of Veterinary Medicine, University of Wisconsin, 250 Linden Dr W, Madison, WI 53706.

[a] Hall L. Educational strategy and curricular development in veterinary medicine for the 21st century. Purdue University, West Lafayette, Ind, 1988.

paid. This will be even more important as tuition costs continue to increase.

Focus on postgraduate training

So far, discussions about swine medicine as a worthwhile career have been restricted to a small group of consulting and practicing veterinarians[7,8] and producers, who have focused more on postgraduate training,[8,9] continuing education,[9,10] and board recognition[11] than on the quantity and quality of swine topics taught in the veterinary schools. Some of these people seem to believe that no more than 5 to 10 new swine veterinarians will be needed each year to fill the needs of the entire US swine industry (about 85 million hogs produced/year), a trend similar to that which has taken place in the poultry industry. It has been suggested that only one veterinary school be selected to educate those students interested in a career in swine medicine. If that were to occur, swine would gradually disappear from the list of species now included in the practices of most mixed food animal practitioners.[3] Of 9,624 veterinarians recently interviewed, 83.5% were classified as mixed food animal practitioners.[3]

Effect of early specialization in the veterinary curriculum

What will happen to the availability of mixed animal practitioners if a plan such as that proposed by the Purdue University School of Veterinary Medicine,[a] is implemented? That plan calls for combining and shortening the preveterinary and basic sciences portions of the veterinary curriculum to 4 years, followed by 2 years of specialization, with licensure limited to the field in which the student specialized during the 3rd and 4th years. Certainly, this would initiate a radical change in most of the multi-veterinarian mixed practices that have developed successfully over the past decades. Many of these practices use partial subdivisions into specialities when one species, frequently swine, constitutes only a minor part of the practice income. Practitioners within the practice group might develop specific areas and species of interest, but still maintain enough professional diversity and basic skills to provide back-up emergency services, and services for colleagues away for vacations or continuing education courses. The mixed practice also provides financial diversity that will balance losses caused by temporary or permanent decline of one species in a geographic area.

The idea of a basic curriculum leading to a general veterinary degree, with limited elective courses available during the 4th year, has worked well and should not be changed unless proven wrong.[12] The justification for specialization because of the "information explosion" has also been challenged.[13] According to White,[13] the amount of basic information needed for any area of interest is less than overwhelming, and an unexamined belief in the information explosion can lead to radical and costly suggestions for curricular reform, including early specialization in veterinary colleges, and curricula based primarily on information management techniques.

State- and industry-supported herd health programs

When I came to the United States and the University of Illinois in 1979, I was surprised at what I viewed as a bias for companion animal medicine (including equine) in the clinical curriculum. After speaking to other western European food animal veterinarians visiting this country, I know that my reactions were shared by them; how could veterinary colleges in the agricultural heartland of the midwest allow small animal and equine medicine and surgery to dominate so much of the curriculum, compared with the traditional food animal and public health training that is considered so important in Europe? After more than 5 years at the University of Illinois and 4 years at the University of Wisconsin-Madison, I realize that the issues and answers are more complex than I first thought.

Some reasons for the differences between the United States and Europe are obvious. In the open market system of the United States, with decreasing state and federal support to higher education, and increasing tuition costs and demands on income from teaching hospitals and other sources, veterinary clincal education has gradually turned to areas of greatest economic return for the schools and their graduates; companion animal and equine medicine. In most western European countries, the university systems are state-funded and students admitted to the professional program do not pay their tuition and other school costs. With this system, studies are free, but the direction of curriculum is influenced by state authorities and the general public (taxpayers), who relate veterinary medicine not only to the well being of animals but also, and equally important, to the needs of the general public in terms of food production and food safety.

Coming to Illinois from Sweden, where for more than 30 years there has been a nationally organized state- and industry-supported swine herd health program in which 25 field veterinarians are employed for an annual production of 4 million hogs, I was surprised to find little state-organized herd health effort in a state producing almost 12 million hogs/year. A comparison with other livestock industries revealed similar discrepancies. In addition to a state-supported system of mixed practices, Sweden has a national dairy herd health program (predominantly mastitis) similar to its swine program. All similar efforts in Illinois and Wisconsin appear to be initiated by and limited to individual veterinary practices. Sweden has more than 15 state and regional veterinary diagnostic laboratories, whereas Illinois has only 4 and Wisconsin has only 2 state laboratories for a livestock population several times the size of Sweden's.

Statewide herd health programs and diagnostic laboratories are not necessarily superior to independent programs performed by herd owners, practitioners, or companies; however, if well organized and well staffed, the programs provide tremendous opportunities for monitoring and controlling disease and production trends for large areas (computerized records on production results and disease statistics were introduced in Sweden 20 years ago). With diagnostic laboratories within close range, fast and effective services can be provided, and together they stand as a symbol of status and strength of food animal and diagnostic veterinary medicine.

Students' attitudes toward swine medicine in the core curriculum

To me, the strength of any program in veterinary medicine begins with the strength of its professional school education. During 1980 at the University of Illinois, 21 (9%) of 230 class hours for instruction in noninfectious and infectious diseases were devoted to swine, 106 (46%) for small animals, 58 (25%) for bovine species, 39 (17%) for horses, and 7 (3%) for exotic animals. In addition, about 30 class hours were required for avian diseases. The clinical core rotations were even less oriented to swine medicine. In 1981, I conducted a survey of students' interests and attitudes toward these courses. Of a class of 85 senior students, 68 responded with comments on the balance of lecture hours between species. They were also asked to indicate their own main species interest or preferred type. Only 17 students (25%) believed that the distribution between species was "quite fair," whereas 38 (56%) expressed concerns that the course distribution was "unfair" to "extremely unfair" to food animals, in particular swine. Interestingly, no more than 11 of 24 students with a strong interest in small animals stated that the distribution was correct or fair, whereas 7 students stated that the distribution of class hours was "probably not fair," and 7 believed that the curriculum was "unfair" to food animals. Among 10 students expressing a strong interest in "mixed practice," only 3 agreed that the time distribution between species was balanced. Two of 10 students with "strictly bovine practice" interest, and none of 17 students expressing "food animal/swine practice" interest, agreed that the distribution was balanced.

Veterinary curricula in North America vs Europe

As a result of the student survey at the University of Illinois, I was assigned a few more lecture hours for swine medicine (up to 24 hours, 12% of the total number of lectures in these courses). At University of Wisconsin-Madison School of Veterinary Medicine, similar arguments elicited departmental support for an increase in the number of required swine medicine lectures from 8 hours (4% of the total medicine lectures) in 1985–1986, to 17 hours (10%) in 1987–1988.

How does this compare with other veterinary schools in the United States and in other countries where swine production is important? Over the past year, I have gathered information about the required and elective course time assigned to swine health and production in several schools in the United States and one in Canada (Guelph; Table 1) as well as schools in Sweden (Uppsala), Norway (Oslo), Finland (Helsinki), Denmark (Copenhagen), West Germany (Giessen), the Netherlands (Ütrecht), and Switzerland (Bern).

Because of different course names, content, and placement in the curriculum, not only between countries but also between schools in the United States, it proved difficult to compare the time and effort assigned to swine. In addition, European veterinary education lasts 5 to 6 years, with no preveterinary requirements. For those reasons, only estimates could be made of the time assigned to teaching medicine, surgery, theriogenology, preventive medicine, and herd health for swine in the veterinary schools surveyed. Most preclinical subjects (such as microbiology, psychology, pathology, pharmacology, and epidemiology), which are less species-oriented, were not included in the survey. Similarly, for most schools, it was not possible to separate the amount of course/lab time assigned to swine for clinical pathology/postmortem examination.

Table 1—Time assigned to teaching swine medicine, surgery, theriogenology, preventive medicine and herd health in selected US and Canadian veterinary schools, 1987–1988

Schools of veterinary medicine	Lecture		Clinical Laboratories		Herd health/field work	
	Required	Elective	Required	Elective	Required	Elective
1. North Carolina	42 h	80 h	45 h	0	1 wk	2 wk
2. Iowa	75 h	45 h	13 h	16 h	4 days	4 days
3. Minnesota	44 h	48 h	8 h	0	2 days	1 wk
4. Indiana	35 h	16 h	3 h	1 wk	1 day	5 wk
5. Illinois	31 h	30 h	12 h	0	3 days	3 wk
6. Wisconsin	25 h	30 h	6 h	0	2 days	2 wk
7. Michigan	20 h	20 h	7 h	0	1 day	60 h
8. Missouri	15 h	17 h	15 h	0	10 h	8 h
9. New York	12 h	0	8 h	0	3 h	0
10. Texas	6 h	16 h	1 h	0	1 day	0
11. Guelph/Canada	39 h	0	5 h	0	1 wk	2 wk

Obviously, there are great differences between the swine programs in the veterinary schools surveyed in the United States and Canada. Schools in states with small swine production apparently put less emphasis on teaching swine diseases, but there are also marked differences between schools in states where swine production is an important part of agriculture (Table 1). Is this consistent with the AVMA rules that American veterinary students are to be offered a sufficiently broad education to include all the important food animals species? I don't think it is.

In the European schools investigated, the number of required lectures on swine diseases varied from about 40 to 100 hours, and practical laboratory/field training from 100 to 200 hours. In addition, most of the schools had extensive courses in ethology, animal hygiene, postmortem examinations/clinical pathology and public health/meat hygiene, with considerable emphasis on swine. The only country emphasizing comprehensive elective courses in swine is Denmark, with 70 hours of lectures and 105 hours of laboratory/field electives required in addition to 100 core hours of lectures and 145 core hours of laboratory/field courses. In addition, 20 lectures and 20 laboratory hours of special pathology plus 10 lectures and 10 laboratory hours of anatomy and 65 lecture hours of meat hygiene are required. As a result, Denmark, where about 15 million hogs are produced each year, has established itself as a world leader of swine veterinary medicine, both in education and in many areas of disease research. An excellent example is the unparalleled success of the Danish national specific pathogen-free herd program. Other European countries follow Denmark on a smaller scale. In Sweden, required swine courses cover more than a month of lectures and laboratory/field courses. Public health/meat hygiene courses, which deal with swine to a considerable extent, cover almost a whole semester of course work. During the summer break between the fourth and fifth year, several students are offered 1- to 2-month assistantships at the national Swine Herd Health Scheme.

Does course time devoted to food animals mean less time devoted to companion animals?

Does more emphasis on swine (and other food animals) mean relatively less time on companion animal courses? The answer must be yes. Does this mean that companion animal veterinarians that graduate from Denmark, Sweden, or Iowa or North Carolina (Table 1), are unfit to work in small animal clinics? I think most would agree that they still can serve their clients well under normal circumstances, despite having received fewer hours of sophisticated specialty teaching, such as dentistry and oncology, compared with veterinarians graduated from small animal-oriented veterinary schools. This raises questions about how much in-depth specialization should be included in the general veterinary curriculum and how postgraduate programs should be organized for those who want to specialize.

My philosophy on teaching of swine medicine in the veterinary core curriculum

How many hours of lectures and clinical/field training are needed to cover the basics of swine medicine? Even though modern swine veterinary medicine is closely integrated with herd management, evaluation of production results, and economics, I believe it is important first to emphasize the basics of the important specific diseases and disease syndromes in the required lectures and clinical teaching such as etiology, prevalence, economic importance, clinical signs and lesions, pathogenesis, treatment, control, and prevention. How can we expect students to know where to start and end a problem-solving approach and analyze the intricate host-agent-environment relationship if they do not know which diseases exist within various organ systems, how they present themselves clinically and interact, and how they can be differentiated from each other?

How much time is needed to cover basics?

My list of swine disease conditions, familiar to every swine veterinary practitioner, includes about 70 infectious and noninfectious diseases, disease syndromes, and abnormalities. Of these, about 50 are important enough to be included in my wish-list for required basic subject matter. Roughly 15 minutes of information about each one of these diseases would total about 17 lecture hours. In addition, basic information about production variables, reproductive physiology, clinical management, the neonatal pig, and important environmental factors that are applied to herd health and epidemiology, would require another 10 to 15 hours. Thus, my minimum list would total 30 to 35 required core hours beyond what is shared between species in the preclinical course programs. Some of the schools investigated (Table 1) come fairly close to these figures.

Each European school surveyed and several of the American schools (No. 1 to 4, Table 1) assign large portions of diagnostic laboratory training of postmortem examinations and applied serology, microbiology, and pathology to the swine program. Diagnostic laboratory work is an essential backbone of swine medicine that cannot be overemphasized. One week of applied laboratory training is a minimum on my wish-list for the required core curriculum.

Field herd exposure is as essential for understanding and applying the concepts of flock/herd animal medicine, epidemiology, and herd health programs as the individual patient is to companion animal veterinary medicine. One herd or one sick animal is not enough to demonstrate the variety of disease expressions that exist. One week of daily herd visits is hardly enough to expose students to the various herd health conditions that exist in the field, but of the schools investigated in the United States, only the University of North Carolina provides that much required field swine herd health work. In comparison, veterinary students in Sweden are required to visit a minimum of 30 swine farms for herd health work. Other European veterinary schools similarly emphasize herd exposure.

For species other than swine, the required course time of clinical rotations is much more extensive in the United States. For instance, at the University of Wisconsin, senior veterinary students have 2 days of swine clinics during 4 weeks of large animal medicine and 2 to 4 weeks of large animal surgery. A minimum of 8 to 10 weeks is required for small animal medicine and surgery. Required clinical rotations in anesthesiology and radiology add important course time to non-swine species. Required ambulatory rotations of 2 weeks in large animal, predominantly dairy practices in Wisconsin, do not change the non-swine clinical teaching pattern. However, in Wisconsin, almost half of the fourth year is available for elective courses and externships, which allows students to explore interests in swine or other fields of veterinary medicine. Most other veterinary schools in the United States have similar arrangements for species such as swine, poultry, and laboratory animals, or nonclinical disciplines in areas such as diagnostic medicine and toxicology, which are not covered by the required core curriculum.

I believe the following questions must be asked: Is it likely that specialty elective programs without core curriculum resources will receive enough school funds and faculty resources to make them meaningful? Is it likely that students with little or no required course exposure will choose elective courses in those fields? Can students justify electives for which they have little or no previous training?

Elective programs: Logical continuation of required core programs

I believe that a meaningful, quality elective program is the logical continuation of a quality core program. I believe that there is enough time for both required core courses and a good variety of quality elective courses during the third and fourth year of veterinary school if the required clinical teaching of all species is restricted to the basics, similar to my "mini-listing" of swine medicine core material. Thus, a broad background, which has been and still seems to be highly appreciated by most veterinarians, will survive with all the benefits previously mentioned, but also will allow students to branch into areas that might be lost without the support of other, stronger "mainstream" fields of veterinary medicine.

The role of veterinarians in whole-herd information-based services

Wise[3] reported that food animal producers give veterinarians excellent ratings for diagnostic and therapeutic skills, but low ratings for knowledge of nutrition, farm economy, and production analysis. Wise indicated that the low-rated areas have to be addressed to improve and expand food animal practices: "Fundamentals of whole herd information-based services must include expertise in subjects such as herd management, production analysis, nutrition, environmental analysis, epidemiology, agribusiness, financial analysis, and the use of computers."

I strongly support the concept of whole-herd information-based services being included in both the veterinary curriculum and, even more, in postgraduate food animal medicine programs; however, I am concerned about the above listing of skills in which epidemiology is the only subject directly related to veterinary medicine in its true sense. Has the crisis in food animal medicine led even veterinarians to believe that veterinary medicine is less important than the other professional areas mentioned in the survey? Is the goal for swine practitioners to become swine producers with a veterinary degree? Or are added degrees in animal science, agricultural engineering, agricultural economy, and business management required for success of a swine-oriented veterinary practice? Several swine veterinarians already have achieved such goals by postgraduate and continuing education, farm experience, and diligent hard practice work with the swine industry.[7,8,14] There should also be great job opportunities in the swine industry for young veterinarians who are motivated and willing to pay the high price of postgraduate education to achieve all these goals. However, I doubt that such an enormous package of education demands will solve the crisis for swine veterinary medicine and provide acceptable veterinary services to the approximately 85 million hogs produced annually in thousands of herds in the United States. First, students come to veterinary schools because of their genuine desire and motivation to work with biological sciences related to animals and their health problems. I see no future for any program in veterinary schools unless we keep those basic ideas in mind. Second, continuously sky-rocketing educational costs effectively limit the course time and content that can be put into the veterinary curriculum and graduate and postgraduate programs. Provocatively stated, if veterinary medicine is not as important to the swine industry as are animal science, agricultural engineering, and economy, it might be better to add courses on swine diseases and epidemiology to the educational programs of those professional groups and have them take the responsibility for applied herd health programs. Farm supply stores and catalogues could be the sole source of medicines, and veterinarians could restrict their involvement to diagnostic laboratory work and research.

There is a reality to such provocative statements. If statements, like "fieldmen post their own pigs,"[14] and "less emphasis should be placed on disease, therapy and vaccination" and "swine practitioners need to become involved in sales training, cash flow analysis, system analysis, structural engineering and marketing schemes,"[15] are not being exaggerated to make a point, most of the content of the veterinary curriculum appears to be a waste of time and money for the swine specialist.

What to do

Swine veterinary medicine is at a crossroad in the United States, and everybody involved ought to think seriously about the issue and how it relates to them.

1) Veterinary educators need to address how to implement a reasonable adjustment to the veterinary core curriculum to make it worthwhile for students with an interest in swine to become swine practitioners, and how to develop quality elective courses and in-depth postgraduate programs focusing on areas that are important to the swine producers and to the health of the pigs and the veterinary profession.

2) Swine practitioners need to express their concerns and suggestions on how to adjust their profession to the changing livestock industry without losing their competitiveness or identity as veterinarians.

3) Veterinary diagnosticians need to emphasize their fundamental role as the true source of expertise for analysis of the direct causes of diseases and health problems, which is essential for the follow-up analysis of the role of herd environmental and other factors to the disease.

4) Veterinary researchers at universities and in the pharmaceutical industry should be continually challenged and stimulated to work with swine health problems of real importance to swine production and, in turn, be better recognized as important participants in the swine veterinary team.

5) State and federally employed veterinarians working with swine disease investigations likewise need recognition for being a part of the swine veterinary team and for their vital contributions to the swine industry.

6) Swine producers have to decide how they want to use veterinary services. Without interesting job opportunities there will be no future for veterinarians in this field. Animal health problems do exist. Any swine practitioner knows that virtually every farm still has swine health problems and that all-in all-out production principles, barn partitions, and feed additives are directly related to control of diseases. Producers continue to express animal health concerns in the annual surveys conducted by NPPC. European experiences tell us that organized herd health schemes contribute to positive producer-veterinarian relationships. Perhaps this is the time to build on the prudent drug use program and establish a similar and more organized relationship between the organizations of swine producers (NPPC) and veterinarians (American Association of Swine Practitioners) to the benefit of both parties.

7) The consumers must also be involved in the issue. In Europe, the general public strongly supports food animal veterinary medicine in public health (meat inspection and food safety) and animal care ethics. What is the perception of food animal veterinarians among the American public? I believe that a survey of those perceptions would be important. At a time when drug residues and food animal welfare issues are being hotly debated, and when consumers are publicly advised to fry their breakfast eggs on both sides to avoid *Salmonella* infection, there is an opportunity and responsibility for veterinarians to take leadership roles for the protection of both animal and public health.

References

1. Proceedings of the ninth symposium on veterinary medical education. *J Vet Med Educ* 1987;14:34–99.

2. Schwabe CW. Utilization of food animals is a necessity and responsibility. *Calif Vet* 1988;42:13–20.

3. Wise JK. The US market for food animal veterinary medical services. Schaumburg, Ill: American Veterinary Medical Association, 1987;1–185.

4. Newham B. Vets have become more things to more people. *Pork '88* 1988;8 (7):4.

5. Vets focus on prudent drug use with on-farm visits (editorial). *Pork Report* 1988;7 (1):6.

6. Ruck D. Sulfa residue testing becomes a critical need. *Swine Pract* 1988;1:6–10.

7. BeVier GW. Swine consultation practice: a telephone and a computer modem. *J Am Vet Med Assoc* 1987;190:154–156.

8. Leman AD. Diagnosis and treatment of food animal educational diseases. *J Am Vet Med Assoc* 1988;193:1066–1067.

9. Wagner WC, BeVier GW, Dierks RE. Training in food animal management: Implications for veterinary curricula. *J Am Vet Med Assoc* 1988;193:46–49.

10. Dial G. AASP membership survey: characteristics and interests of the swine practitioner, in *Proceedings*. Am Assoc Swine Pract 1988;161–170.

11. Wilson MR. The need for swine health management specialty training. Kernkamp Lecture, in *Proceedings*. Swine Herd Health Prog Conf 1986;433–440.

12. Kitchen H. Essentials for the DVM degree: insuring flexibility. *J Vet Med Educ* 1987;14:92–94.

13. White ME. Let's stop loose talk about the "Information explosion." *J Vet Med Educ* 1988;15:25–26.

14. Wetzell TF. Thirty-two years of marketing large animal practice. *Anim Health Nutr Large Anim Vet* 1988;43:4:6–8.

15. Herrick JB. The future of large animal practice. *Anim Health Nutr Large Anim Vet* 1988;43:9–14.

Economic Note

1987 incomes of US Veterinarians

The American Veterinary Medical Association conducted an economic survey of US veterinarians in the spring of 1988. The purpose of the survey was to secure accurate data on veterinarians' earnings in private practice and in nonprivate practice employment. Findings from the survey, to be published in *JAVMA* in the coming months, should be useful because they provide information on veterinarians' incomes according to type of employment, years of experience, and other important characteristics. In addition, valuable national data will be provided on economic returns to private veterinary practice, staff numbers, cash operating expenses, and other practice characteristics.

Survey method and sample size

The sample of veterinarians was selected randomly from AVMA's computerized records of 40,190 nonretired member and nonmember veterinarians. In the private practice sector, survey questionnaires were mailed to 1,000 veterinarians in each of 6 categories of private practice: large animal exclusive, large animal predominant, mixed animal (50% large, 50% small), small animal predominant, small animal exclusive, and equine. The large animal exclusive group included veterinarians engaged in bovine, porcine, and poultry practice, but not equine practice. Each group was sampled equally to ensure statistically reliable estimates for each type and to permit analysis within each group. The survey also included 1,000 randomly selected veterinarians employed in private practice, but who were not classifiable according to the aforementioned 6 types of private practice.

In the nonprivate practice sector, questionnaires were mailed to 500 veterinarians in each of 4 nonprivate practice categories: college or university, federal government, state or local government, and industry or other employers. Surveys also were mailed to all 491 armed forces veterinarians listed in AVMA records as residing in the United States. The total survey sample consisted of 9,491 US veterinarians (Table 1).

An advance letter was mailed to all veterinarians in the sample on Mar 18, 1988, alerting them that they would soon receive the biennial economic survey. The questionnaire was mailed on March 24 and was followed by 2 mailings of reminder postcards. When the survey was terminated (May 20), 4,350 (46%) questionnaires had been returned to the AVMA. The sample of respondents was determined to be representative of the US veterinary medical population with respect to geographic, sex, and age distributions.

The survey questionnaire was identical to the one used for the 1986 AVMA biennial economic survey.[1] Section 1 was completed by all veterinarians in private and nonprivate practice

Table 1—1988 biennial economic survey sample

	No. of veterinarians in population	No. of veterinarians in sample	No. of respondents	Percentage response
Veterinarians in private practice				
Large animal exclusive	1,584	1,000	207	21
Large animal predominant	4,463	1,000	346	35
Mixed animal	3,121	1,000	360	36
Small animal predominant	4,744	1,000	517	52
Small animal exclusive	17,049	1,000	734	73
Equine	1,585	1,000	311	31
Other types	1,122	1,000	79	8
All practice types	33,668	7,000	2,554	38
Veterinarians not in private practice				
College or university	4,157	500	300	60
Federal government	1,487	500	325	65
State or local government	842	500	288	58
Armed forces	491	491	275	56
Industry or other	2,655	500	608	122
All employer types	9,632	2,491	1,796	72
Total veterinarians	43,300	9,491	4,350	46

Prepared by J. Karl Wise, PhD, Wisemark Associates, PO Box 681189, Schaumburg, IL 60168-1189.

This report is the first in a series of monthly Economic Notes summarizing results of the 1988 AVMA Biennial Economic Survey.

Table 2—Mean incomes of veterinarians in private practice, 1987

Type of practice	Mean income ($)	Median income ($)	No. of respondents
Large animal exclusive	56,464	48,250	153
Large animal predominant	49,384	41,928	290
Mixed animal	45,434	34,900	296
Small animal predominant	50,608	37,900	411
Small animal exclusive	54,118	39,700	529
Equine predominant	60,653	40,480	228
All practice types	52,643*	39,793*	1,907

*Weighted estimates based on total population of 33,668 veterinarians in private practice.

and included questions on individuals' 1987 incomes, type of practice or employment, years of experience, age, sex, fringe benefits, hours and weeks worked, practice ownership status, and share of capital investment in practice real estate and equipment. Section 2 was completed only by veterinarians who were private practice owners, ie, sole proprietors, partners, or shareholders in private veterinary practices. Information was provided on type of practice, facility and organizational form, assets and liabilities, market and community size, 1987 gross practice income, and 1987 operating expenses.

Income analysis

Veterinarians indicated their 1987 individual income, before personal taxes, from professional veterinary medical activity, including income from practice, salary, profit sharting, and bonuses. If the respondent was the owner of a veterinary practice, the owner's return from capital invested (ie, practice real estate) was included as income, even if leased by the owner to the practice.

Respondents reported individual net incomes at $3,000 increments ranging from "less than $16,000" to "$76,000 or more." Responses from veterinary practice owners were reviewed in detail to obtain valid estimates of net practice income. Specifically, reported individual net income of owners was compared with computations made on the owner-respondent's practice income and expense data. For this analysis, individual private practice net income included return on capital invested, labor, and management. In other words, practice owners' return on practice investment has not been deducted from income. A future report will focus on this measure of practice owner income.

Mean income was calculated by summing all income values and dividing by the number of respondents. Median income was calculated (based on interval midpoints) as the income level that divided the income distribution in half, ie, 50% of all veterinarians earning incomes below and 50% above this income level. Respondents were included in this analysis if they worked on the average at least 30 hours/week, and at least 48 weeks in their reported type of practice or employment in 1987.

Veterinarians in private practice

The 1987 mean individual net income, before personal taxes, of US veterinarians in private practice was $52,643 (Table 2). Mean income for specific types of private practice ranged from lows of $45,434 for mixed animal practitioners and $49,384 for large animal predominant practitioners to a high of $60,653 for equine practitioners. Mean income for large animal exclusive practitioners was $56,464, and for small animal predominant and small animal exclusive practitioners, income was $50,608 and $54,118, respectively.

The 1987 median individual net income of US veterinarians in private practice was $39,793. The median incomes ranged from $34,900 for mixed animal practice to $48,250 for large animal exclusive practice. In every type of practice, the median income was less than the mean income. This difference highlights the fact that few very high incomes offset many lower incomes to yield a mean higher than the median.

A comparison of mean incomes for 1985 and 1987 showed that private practice income increased 9.5% or about 4.7%/year. Large animal exclusive practitioners showed the greatest percentage increase (29.8%) over the 2-year period. Percentage increases from 1985 to 1987 for other practice types were as follows: large animal predominant,

Table 3—Percentage distribution of veterinarians in private practice, by income classes, 1987

Income class ($)	Large animal exclusive	Large animal predominant	Mixed animal	Small animal predominant	Small animal exclusive	Equine
Less than 25,000	9.9	13.1	21.0	21.0	15.5	17.2
25,000 to 36,999	24.4	26.6	30.0	25.5	29.4	25.3
37,000 to 48,999	14.4	19.0	11.9	16.3	14.2	15.8
49,000 to 60,999	12.5	17.3	13.7	9.3	11.7	10.1
61,000 to 72,999	14.5	9.6	10.5	6.8	8.1	7.4
73,000 to 84,999	9.2	6.8	4.1	6.5	5.2	5.3
85,000 to 96,999	3.3	2.7	3.8	6.6	3.2	4.4
97,000 or more	11.8	5.1	5.0	8.0	12.7	14.4
	100 (153)*	100 (290)	100 (296)	100 (411)	100 (529)	100 (228)

*Number of usable responses in parentheses.

Table 4—Mean incomes of veterinarians not in private practice, 1987

Type of employer	Mean income ($)	Median income ($)	No. of respondents
College or university	50,739	49,000	246
Federal government	45,477	42,000	240
State or local government	45,500	42,786	247
Armed forces	43,365	40,409	238
Industry/commercial	65,321	58,000	149
Other/not-for-profit organizations	51,747	43,000	89
All employer types	51,995*	48,182*	1,209

*Weighted estimates based on population of 9,632 veterinarians in private practice.

4%; mixed animal, 4.9%; small animal predominant, 6.8%; small animal exclusive, 10.2%; and equine predominant, 8.3%.

Interestingly, in 1985, large animal exclusive practitioners had lower incomes, on average, than other types of practitioners and suffered a 6.1% decrease from 1983 to 1985.[1]

For each type of private practice, percentages of veterinarians were determined for income classes ranging from less than $25,000 to more than $97,000 (Table 3). Each income class represented an income interval of $12,000. Comparisons of percentages of veterinarians in particular income classes indicated greater income variation in some types of practices than in others. For example, at least 11% of large animal exclusive, small animal exclusive, and equine practitioners earned more than $97,000 in 1987, compared with only 5% of large animal predominant and mixed animal practitioners who earned at least that amount. Twenty-one percent of mixed animal and small animal predominant practitioners earned less than $25,000, compared with 9.9% of large animal exclusive practitioners.

Veterinarians not in private practice

The 1987 mean income of US veterinarians not in private practice was $51,995 (Table 4). Mean incomes for specific types of nonprivate practice ranged from a low of $43,365 for armed forces veterinarians to a high of $65,321 for veterinarians in industry. Mean incomes for other nonprivate practice types were $45,477 for federal government, $45,500 for state or local government, $50,739 for college or university, and $51,747 for other/not-for-profit organizations.

The 1987 median individual income of US veterinarians not in private practice was $48,182. The median incomes ranged from a low of $40,409 for armed forces to a high of $58,000 for industry. A comparison of the mean and median incomes indicated that the difference between them was small, which suggests there were relatively few high incomes.

A comparison with 1985 incomes showed that mean nonprivate practice incomes increased 10% over the 2-year period. With the exception of other/not-for-profit organizations, where the mean income declined 3.3%, mean incomes for each nonprivate practice type increased from 1985 to 1987. Mean incomes increased as follows: college or university, 16.4%; federal government, 5%; state or local government, 12.2%; armed forces, 4%; industry/commercial, 4.4% (Table 5).

Reliability of 1987 income estimates

Estimates of veterinarians' incomes derived from sample surveys are subject to sampling errors that arise because observations are made on only a portion of the total population. To make statistical inferences about true population mean incomes, it is useful to determine confidence intervals.

A confidence interval is a range of values that has a predetermined probability of including the true population mean income. For example, it may be stated that there is a 95% probability that the estimated mean income plus or minus 2 SE will encompass the true, but unknown, population mean income.

Confidence intervals of the true mean incomes in 1987 for all private and nonprivate practice types were determined (Table 6). For all private practitioners, one can be 95% confident that the interval $50,963 to $54,323

Table 5—Percentage distribution of veterinarians not in private practice, by income classes, 1987

Income class ($)	College or university	Federal government	State or local government	Armed forces	Industry/ commercial	Other/ Not-for-profit
Less than 25,000	12.8	1.4	2.0	4.2	2.8	18.0
25,000 to 36,999	8.6	26.4	24.8	26.9	11.7	19.1
37,000 to 48,999	26.7	40.1	41.1	38.6	18.9	19.3
49,000 to 60,999	23.1	18.4	19.9	20.2	18.6	15.7
61,000 to 72,999	17.7	10.4	9.7	10.1	16.5	10.1
73,000 to 84,999	5.4	2.5	1.2	...	11.0	5.6
85,000 to 96,999	2.9	0.4	0.8	...	6.2	3.3
97,000 or more	2.8	0.4	0.4	...	14.5	8.9
	100 (246)*	100 (240)	100 (247)	100 (238)	100 (149)	100 (89)

*Number of usable responses in parentheses.

Table 6—Mean income confidence intervals for US veterinarians, 1987

	Estimated mean income ($)	SE of estimated mean income ($)	95% confidence interval of true mean income ($)*
Veterinarians in private practice			
Large animal exclusive	56,464	2,610	$51,349 \le \mu \le 61,579$
Large animal predominant	49,384	1,642	$46,166 \le \mu \le 52,609$
Mixed animal	45,434	1,683	$42,138 \le \mu \le 48,732$
Small animal predominant	50,618	1,757	$47,174 \le \mu \le 54,062$
Small animal exclusive	54,118	1,747	$50,694 \le \mu \le 57,542$
Equine	60,653	4,007	$52,800 \le \mu \le 68,506$
All practice types	52,643	857	$50,963 \le \mu \le 54,323$
Veterinarians not in private practice			
College or university	50,739	1,348	$48,097 \le \mu \le 53,381$
Federal government	45,477	871	$43,770 \le \mu \le 47,184$
State or local government	45,500	788	$43,955 \le \mu \le 47,044$
Armed forces	43,365	764	$41,868 \le \mu \le 44,862$
Industry/commercial	65,321	2,571	$60,282 \le \mu \le 70,360$
Other/not-for-profit organization	51,747	3,641	$44,611 \le \mu \le 58,883$
All employer types	51,995	627	$50,766 \le \mu \le 53,224$

*Form of confidence interval is $(\bar{x} - t\sigma_{\bar{x}}) \le \mu \le (\bar{x} + t\sigma_{\bar{x}})$ where $\bar{x}$ is mean income, t is 1.96, $\sigma_{\bar{x}}$ is SE of the mean income, and μ is the true mean income.

will encompass the true 1987 mean income. Because of the smaller samples sizes in each of the 6 private practices and 6 nonprivate practice types, 95% confidence intervals are greater, ranging from $3,000 to $12,000.

Because a mean income estimate is influenced by extreme values at the high end of an income distribution, the median estimate often is considered a more meaningful estimate of the central income level of a population.

Reference

1. Wise JK. 1985 incomes of US veterinarians. *J Am Vet Med Assoc* 1987; 190:1333–1336.

A3100-2
3/17/89

March 15, 1989, Volume 194, Number 6

JOURNAL
OF THE AMERICAN VETERINARY MEDICAL ASSOCIATION

8001852621 031589 2 23 J
CONGRESSIONAL INFO SERV ##
MR ED KIANKA STAT REF INDEX ##
4520 EAST WEST HWY ##
BETHESDA MD 20814 ##

Research Roundup

The threat of aflatoxins 743

The *Human* Side of Veterinary Medicine

Client beliefs vs veterinary attitudes 760

Zoonosis Update

Coxiella burnetii infection (Q fever) 764

Food Animal Economics

Impact of trichomoniasis on the cow-calf producer's profitability 771

Economic Note

1987 Professional incomes of US veterinarians, by hours worked and years since graduation 815

JOURNAL OF THE AMERICAN VETERINARY MEDICAL ASSOCIATION

© American Veterinary Medical Association, 1989
All Rights Reserved

Vol 194 March 15, 1989 No. 6
JAVMA 194(6) 737-856 (1989)
ISSN 0003-1488

Letters

Apprehensive about some trends in the profession 740
Transmission of leishmaniasis 741
Education running a poor third 741
Image for National Pet Week 741
Hopes American veterinarians consider career in international agriculture 742

News

Research Roundup—The threat of aflatoxins 743
Student and School Scenes—Students help raptors to recuperate 747
Regulatory Front—Equine drug use: protecting your license 748
Practice Management—What about advertising? 750
Pages from the Past—The etymology of *veterinarian* 751
Fireside Chat—Travels broaden president's vision 752
Washington Watch—Medical waste: confusion reigns 754
Coast to Coast 756
Technicians Today—Correspondence schools not accredited by AVMA 757
Out and About 758
Deaths 758

The *Human* Side of Veterinary Medicine

Client beliefs vs veterinary attitudes—*Jacob Antelyes* 760

Zoonosis Update

Coxiella burnetii infection (Q fever)—*Darrell Behymer and Hans P. Riemann* 764

Interpretive Summaries of Articles in This Issue 768

Food Animal Economics

Impact of trichomoniasis on the cow-calf producer's profitability—*D. O. Rae* 771

Reports of Original Studies

Ocular manifestations of Rocky Mountain spotted fever in dogs—*Michael G. Davidson, Edward B. Breitschwerdt, Mark P. Nasisse, and Steven M. Roberts* 777

Use of ketoconazole in the treatment of canine nasal aspergillosis—*Nicholas J. H. Sharp and Martin Sullivan* 782

Clinical Reports

Recurring tetraparesis attributable to a heartworm in the epidural space of a dog—*Charles E. Blass, Robert A. Holmes, and T. Mark Neer* 787

Paraparesis caused by epidural granuloma in a cat—*Karl H. Kraus, Lisa M. Butler, and Eric R. Pope* 789

Treatment of cataplexy in a dog with narcolepsy—*Joan C. Hendricks and Carolyn Hughes* 791

Malignant lymphoma with cardiac and bone involvement in a dog—*Gregory K. Ogilvie, Connie S. Brunkow, Gregory B. Daniel, and Wanda M. Haschek* 793

Eumycotic mycetoma caused by *Pseudallescheria boydii* in a dog—*Neil Allison, Robert K. McDonald, Steven R. Guist, and John Bentinck-Smith* 797

Reversal of atrial tachycardia with intravenous administration of verapamil in a dog—*M. S. Foodman and D. Macintire* 800

Reports of Retrospective Studies

Mucocutaneous plasmacytomas in dogs: 75 cases (1980-1987)—*Pauline M. Rakich, Kenneth S. Latimer, Raul Weiss, and W. L. Steffens* 803

Failure of omasal transport attributable to perireticular abscess formation in cattle: 29 cases (1980-1986)—*Susan L. Fubini, Normand G. Ducharme, Hollis N. Erb, Donald F. Smith, and William C. Rebhun* 811

Economic Note

1987 Professional incomes of US veterinarians, by hours worked and years since graduation—*J. Karl Wise* 815

What Is Your Diagnosis?

Robert S. Kieval and Nathan L. Dykes 819

Book Reviews

Concise Veterinary Dictionary 792
Veterinary Clinical Immunology 799
Structure and Function of Domestic Animals 802
Rabies 820
Books received but not reviewed 786

Abstracts of Selected Reports

Prevention of aflatoxicosis by addition of hydrated sodium calcium aluminosilicate to the diets of growing barrows 814

Announcements

Coming Meetings 822
Foreign Meetings 824
Educational Opportunities 829
Applications for Membership 831
Certification Examinations 832
State Board Examinations 832

Classified Ads 835

Coming Soon . . .

April 1 issue

Special Report—Effects of the Chernobyl accident on animal husbandry and production, from a Swedish perspective (B-E. Jones)

Legal Brief—Biotechnology and the veterinarian—some legal considerations (H. W. Hannah)

Reflections—From upstate New York to Concord, Mass: An experience to cherish (E. W. Tucker)

Blindness and sexual dimorphism associated with vitamin A deficiency in feedlot cattle (M. E. Paulsen et al)

Pyelonephritis in cows: 15 cases (W. C. Rebhun et al)

April 15 issue

Economic Note—1987 US veterinary practice income, expenses, and financial ratios (J. K. Wise)

The *Human* Side of Veterinary Medicine—Narcissistic clients (J. Antelyes)

Zoonosis Update—Anthrax (L. Hunter et al)

Intramammary antibiotic treatment at the end of lactation for prophylaxis and treatment of intramammary infections in ewes (W. D. Hueston et al)

Research Roundup—Bovine somatotropins: Benefits and risks

Economic Note

1987 Professional incomes of US veterinarians, by hours worked and years since graduation

In 1987, the mean income of veterinarians in private practice was $52,643, and the mean income of veterinarians not in private practice was $51,995.[1] In this report, veterinarians' incomes are reported separately for private practice owners and private practice employees. Owners' individual incomes have been reduced computationally by a 12% return on the owners' equity in fixed assets used in the practice; thus, owners' individual income represents only professional veterinary medical income. This income adjustment permits a more realistic comparison of private practice owners', practice employees', and nonprivate practicing veterinarians' 1987 incomes according to hours worked and years of experience.

Mean income, by hours worked

Veterinarians indicated their 1987 individual net income, before personal taxes, from professional veterinary medical activity, including income from practice, salary, profit sharing, and bonuses. Mean income was calculated as the arithmetic mean by summing all income values and dividing by the number of respondents. Respondents were included in the analysis if they worked on the average at least 30 h/wk and at least 48 weeks in their reported practice type or for their employer in 1987.

In 1987, the mean professional income of US veterinarians in private practice was $46,692 (Table 1), which represents a 9.9% increase from $42,498 in 1985.[2] The mean number of hours worked per week in professional veterinary medical activity was 52.4 hours. For 50 weeks worked per year, US private practitioners earned an average of $18.16/h in 1987, ranging from $14.18/h for mixed animal practice to $19.55/h for small animal exclusive practice.

For private practice owners, mean 1987 professional income was $57,303, up 12.2% from $51,064 in 1985 (Table 1). Figure 1 shows percentage increases in mean professional incomes for private practice owners from 1985 to 1987. Large animal practice owners' 1987 mean incomes showed a remarkable 49% increase over 1985; this follows an 11% decline from 1983 to 1985.[3]

Practice owners and employees worked similar hours in

Table 1—Mean professional income and hours worked for veterinarians in private practice, 1987

	Large animal exclusive	Large animal predominant	Mixed animal	Small animal predominant	Small animal exclusive	Equine	All practices
Veterinarian-owners							
Mean income*	$61,887	$51,926	$47,392	$50,758	$60,673	$68,883	$57,303
(No. of responses)	(95)	(184)	(169)	(230)	(232)	(117)	
Mean hours worked/wk	56.5	57.9	57.8	53.6	50.2	56.7	53.2
Mean income/h†	$21.98	$18.19	$16.37	$19.18	$24.65	$22.78	$21.98
Veterinarian-employees							
Mean income	$31,767	$30,514	$28,810	$30,634	$33,792	$39,685	$32,650
(No. of responses)	(30)	(68)	(93)	(122)	(245)	(78)	
Mean hours worked/wk	60.3	56.3	57.4	52.7	47.0	60.8	51.5
Mean income/h	$10.96	$11.04	$10.20	$12.14	$14.72	$13.33	$13.18
All veterinarians in private practice							
Mean income‡	$54,659	$46,149	$40,798	$43,784	$46,868	$57,196	$46,692
(No. of responses)	(125)	(252)	(262)	(352)	(477)	(195)	
Mean hours worked/wk	57.3	57.5	57.5	53.3	48.7	58.1	52.4
Mean income/h	$19.34	$18.25	$14.18	$16.74	$19.55	$19.00	$18.16

*Mean income for private practice owners defined as mean return to labor and management, ie, individual net practice income less 12% return on owner's equity in the practice (fair market value of fixed assets less long-term debt). †Income/h based on estimated 50 weeks worked per year. ‡Weighted mean of private practice owners' and employees' incomes by practice type.

Prepared by J. Karl Wise, PhD, Wisemark Associates, PO Box 681189, Schaumburg, IL 60168-1189.

This report is the second in a series of monthly Economic Notes summarizing results of the 1988 AVMA Biennial Economic Survey.

Table 2—Mean professional income and hours worked for veterinarians not in private practice, 1987

	College or university	Federal government	State or local government	Armed forces	Industry	Other/not-for-profit organization	All employers
Mean income	$50,739	$45,477	$45,500	$43,365	$65,321	$51,747	$51,995
(No. of responses)	(246)	(240)	(247)	(238)	(149)	(89)	
Mean hours worked/wk	53.4	46.6	43.6	49.1	47.6	50.7	49.9
Mean income/h*	$19.57	$20.09	$21.17	$18.12	$27.76	$20.89	$21.41

Based on estimated 50 weeks worked/yr.

Table 3—Mean professional incomes of private practice owners by years since graduation, 1987

Years since graduation	Large animal exclusive	Large animal predominant	Mixed animal	Small animal predominant	Small animal exclusive	Equine
3 to 7*	$43,968 (11)†	$57,089 (33)	$47,192 (25)	$41,230 (42)	$38,746 (31)	$48,980 (33)
8 to 12	77,649 (20)	47,312 (46)	49,879 (56)	49,721 (71)	51,482 (53)	61,368 (23)
13 to 17	70,997 (12)	45,775 (22)	48,343 (18)	65,313 (29)	66,873 (38)	129,933 (15)
18 to 22	61,638 (16)	50,993 (23)	48,875 (23)	56,880 (31)	67,452 (34)	65,716 (17)
23 to 27	70,426 (10)	59,234 (22)	51,938 (11)	54,883 (21)	·69,457 (32)	94,392 (13)
28 to 32	43,419 (7)	69,615 (17)	43,716 (12)	42,283 (13)	85,181 (13)	47,598 (7)
33 to 40	55,415 (7)	41,624 (12)	43,816 (10)	50,243 (13)	55,460 (16)	. . .
>40	52,357 (10)	35,085 (6)	38,206 (12)	43,135 (9)	72,974 (15)	60,300 (6)

*Mean income for private practice owners defined as mean return to labor and management, ie, individual net practice income less 12% return on owner's equity in the practice (fair market value of fixed assets less long-term debt). †Number of usable responses in parentheses.

Table 4—Mean professional incomes of private practice employees by years since graduation, 1987

Years since graduation	Large animal exclusive	Large animal predominant	Mixed animal	Small animal predominant	Small animal exclusive	Equine
1 to 2	$23,416 (6)*	$26,500 (14)	$24,464 (28)	$24,336 (25)	$26,330 (53)	$27,200 (17)
3 to 7	32,066 (15)	28,527 (37)	27,846 (45)	30,960 (76)	32,267 (127)	34,545 (44)
8 to 12	32,833 (9)	37,000 (4)	35,823 (13)	34,500 (9)	42,975 (41)	56,041 (12)
13 to 17	. . .	. . .	. . .	43,000 (4)	47,000 (5)	. . .

*Number of usable responses in parentheses.

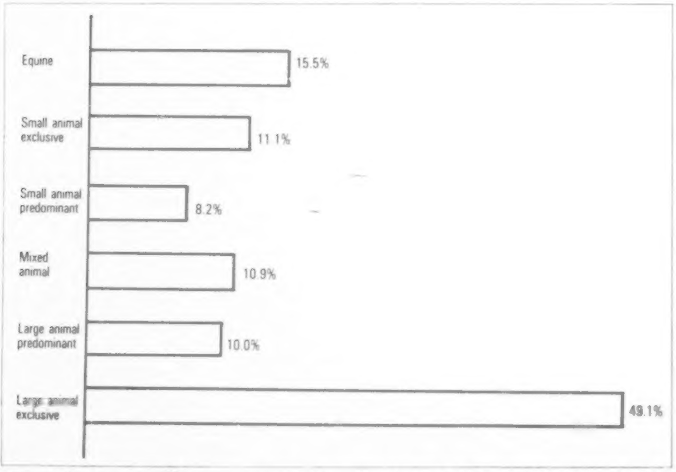


Figure 1—Percentage increase in mean private practice owners' professional incomes, 1985 to 1987.

1987, according to type of practice. A comparison with 1985 indicated that across practice types, with the exception of equine practice, veterinarians worked slightly more hours per week in 1987 (52.4 h/wk) than 1985 (51.2 h/wk).

Veterinarian-employees earned $13.18/h, up $0.67 from 1985 (5.3%). Veterinarian-owners increased their hourly earnings from $20.18 in 1985 to $21.98 in 1985, an increase of $1.80/h (8.2%).

The mean 1987 income of US veterinarians not in private practice was $51,995 (Table 2). The mean number of hours worked per week to earn income in professional veterinary medical activity was 49.9 hours, ranging from 43.6 hours in state or local government to 53.4 hours in academia.

On the basis of 50 weeks worked per year, nonprivate practice veterinarians earned an average of $21.41/h in 1987, up $1.92/h from 1985 (9.8%).

Mean income, by years since graduation

Professional incomes were analyzed by the number of years since graduation from veterinary medical college. Considerable variation in realized earnings exists over the careers of private practice owners in different types of practice (Table 3). With a few exceptions, peak earning years for most practice owners appear to be 23 to 32 years after graduation. Most likely due to the influence of several very high incomes, highest earnings for large animal exclusive and equine practice owners were 8 to 17 years after graduation.

With respect to veterinarians employed in private prac-

Table 5—Mean professional incomes of veterinarians not in private practice by years since graduation, 1987

Years since graduation	College or university	Federal government	State or local government	Armed forces	Industry	Other/not-for profit organization
3 to 7	31,535 (42)*	31,250 (30)	34,395 (19)	33,940 (50)	42,940 (25)	32,861 (18)
8 to 12	42,379 (58)	40,000 (40)	40,660 (28)	40,171 (70)	62,516 (30)	38,576 (13)
13 to 17	55,980 (26)	43,372 (22)	43,300 (25)	45,464 (28)	69,866 (15)	46,125 (8)
18 to 22	56,092 (27)	43,818 (22)	46,919 (31)	54,285 (42)	68,875 (20)	53,966 (15)
23 to 27	68,125 (28)	53,473 (38)	50,333 (27)	59,852 (17)	81,391 (18)	56,222 (9)
28 to 32	67,184 (29)	53,369 (46)	47,706 (46)	61,642 (7)	75,125 (12)	72,250 (10)
33 to 40	60,975 (20)	50,706 (29)	46,159 (47)	. . .	84,662 (14)	77,821 (11)
>40	50,136 (11)	41,800 (10)	50,432 (22)	39,166 (9)	66,800 (10)	49,900 (5)

*Number of usable responses in parentheses.

tice, mean professional incomes were estimated for 4 groups by years since graduation: 1 to 2 years, 3 to 7 years, 8 to 12 years, and 13 to 17 years (Table 4). As in 1985, mean incomes of veterinarians employed in large animal exclusive practices were stable after 3 to 7 years of experience. For all other practice types, mean earnings for employed veterinarians increased steadily.

Mean professional incomes of veterinarians not in private practice were also analyzed with respect to number of years since graduation (Table 5). In contrast to private practice owners, earnings of those in nonprivate practice showed a relatively steady growth pattern throughout veterinarians' careers in industry, government, and academia. As in 1985, earnings were highest in industry in all groups by years since graduation.

---

1. Wise JK. 1987 incomes of US veterinarians. *J Am Vet Med Assoc* 1989;194:563–566.

2. Wise JK. 1985 Professional incomes of US veterinarians, by hours worked and years since graduation. *J Am Vet Med Assoc* 1987;191:246–248.

3. Wise JK. 1983 Professional incomes of US veterinarians, by hours worked and years since graduation. *J Am Vet Med Assoc* 1985;186:1108–1110.

A3100-2
4/12/89

April 15, 1989, Volume 194, Number 8

JOURNAL
OF THE AMERICAN VETERINARY MEDICAL ASSOCIATION

Research Roundup
Bovine somatotropins: Benefits and risks 1009

Letters
Confusion over toxicity of poinsettia 1004

Taurine for cats 1005

Zoonosis Update
Anthrax 1028

The *Human* Side of Veterinary Medicine
Narcissistic clients 1032

Economic Note
1987 US veterinary practice income, expenses, and financial ratios 1100

800185262 1 041569 2 23 J
CONGRESSIONAL INFO SERV **
MR ED KIANKA STAT REF INDEX **
4520 EAST WEST HWY **

JOURNAL OF THE AMERICAN VETERINARY MEDICAL ASSOCIATION

©American Veterinary Medical Association, 1989
All Rights Reserved

Vol 194 April 15, 1989 No. 8
JAVMA 194(8) 1001-1144 (1989)
ISSN 0003-1488

Letters

On use of "veterinary" 1004
Confusion over toxicity of poinsettia 1004
Animal technicians—the glue that holds a practice together 1005
Nasal bone fractures in Greyhounds 1005
Taurine for cats 1005
Regards commentary on animal rights as insensitive 1006
Liposuction for cats? 1006
Veterinarians should be aware of ecologic and environmental problems 1006

News

Research Roundup—Bovine somatotropins: benefits and risks 1009
AVMA at Work 1013
Edge of Education—Veterinary medical education today 1014
Insurance Information—How insurance rates are determined 1016
Washington Watch—Federal legislation pending 1017
Awards and Honors 1017
Regulatory Front—Dispensing drugs to nonclients is risky 1018
Alabama's sign averts problems 1018
Under the Umbrella 1019
Pages from the Past—Mark Francis: the man and the legend 1020
Coast to Coast 1022
Out and About 1025
Deaths 1026

Zoonosis Update

Anthrax—*Lee Hunter, Wayne Corbett, and Carol Grindem* 1028

The *Human* Side of Veterinary Medicine

Narcissistic clients—*Jacob Antelyes* 1032

Interpretive Summaries of Articles in This Issue 1036

Reports of Original Studies

Intramammary antibiotic treatment at the end of lactation for prophylaxis and treatment of intramammary infections in ewes—*William D. Hueston, Garnard J. Boner, and Steven L. Baertsche* . . 1041

Contribution of propylene glycol-induced Heinz body formation to anemia in cats—*Mary M. Christopher, Victor Perman, and John W. Eaton* 1045

Preservation of striated-muscle urethral sphincter function with use of a surgical technique for perineal urethrostomy in cats—*D. W. Griffin, C. R. Gregory, and R. L. Kitchell* 1057

Clinical Reports

Microlithiasis associated with chronic bronchopneumonia in a cat—*David G. Brummer, Tracy W. French, and J. Mark Cline* 1061

Repair of pectus excavatum by percutaneous suturing and temporary external coaptation in a kitten—*Jonathan F. McAnulty and Colin E. Harvey* 1065

Fragments of nasogastric tubes as esophageal foreign bodies in two horses—*A. N. Baird and Claudia K. True* 1068

Synovial hernia as a possible complication of arthroscopic surgery in a horse—*David G. Wilson* 1071

X-ray computed tomography-aided diagnosis of nasal adenocarcinoma, with extension to the skull and central nervous system, in a dog—*J. E. Sackman, W. H. Adams, and M. D. McGavin* 1073

Generalized skeletal involvement of a hematopoietic tumor in a dog—*Linda Shell, Debbie J. Davenport, Don L. Barber, and William Chickering* 1077

Parosteal osteosarcoma of the mandible in a dog—*James D. Brogdon, Alan H. Brightman, Lloyd C. Helper, Susan A. Mclaughlin, and Ann L. Johnson* 1079

Redefined type of elbow dysplasia involving calcified flexor tendons attached to the medial humeral epicondyle in three dogs—*William J. Zontine, Raymond A. Weitkamp, and C. L. Lippincott* 1082

Congenital central diabetes insipidus in two sibling Afghan Hound pups—*K. Post, J. R. J. McNeill, E. G. Clark, M. A. Dignean, and G. P. Olynyk* 1086

Reports of Retrospective Studies

Relation of endogenous Heinz bodies to disease and anemia in cats: 120 cases (1978-1987)—*Mary M. Christopher* 1089

Horner's syndrome in dogs and cats: 49 cases (1980-1986)—*Rhea V. Morgan and Stephen W. Zanotti* 1096

Economic Note

1987 US veterinary practice income, expenses, and financial ratios—*J. Karl Wise* 1100

What Is Your Diagnosis?

A. J. Payton, S. E. Moos, R. L. Pulver, and W. J. Maier 1105

Book Reviews

The Biology and Medicine of Rabbits and Rodents 1070
Parasitology: The Biology of Animal Parasites 1081
Books received but not reviewed 1076

Abstracts of Selected Reports

Suppression of preovulatory luteinizing hormone surges in heifers after intrauterine infusions of *Escherichia coli* endotoxin ... 1056
Hemolytic anemia and red blood cell metabolic disorder attributable to low phosphorus intake in cows 1088

New veterinary biological products . 1078

Announcements

Coming Meetings 1110
Foreign Meetings 1112
Applications for Membership 1113
Certification Examinations 1114
State Board Examinations 1114
Educational Opportunities 1116

Classified Ads 1121

Coming Soon . . .

May 1 issue

Comparison of bronchodilators in alleviating clinical signs in horses with chronic obstructive pulmonary disease (E. G. Pearson and T. W. Riebold)

Reflections—Carving out a career in Arizona (A. M. Smith)

Special Report—Developing standards on animal research review (R. Dresser)

Plasma concentrations of oxytetracycline in swine after administration of the drug intramuscularly and orally in feed (W. F. Hall et al)

May 15 issue

Research Roundup—Latest on *Borrelia burgdorferi* infection

The *Human* Side of Veterinary Medicine—Hagglers, slow players, and no payers (J. Antelyes)

Economic Note—Trends in veterinarians' incomes

Side effects of etomidate in dogs (W. W. Muir and D. E. Mason)

Clinical features of salmonellosis in cats (S. W. Dow et al)

Economic Note

1987 US veterinary practice income, expenses, and financial ratios

The 1988 AVMA Biennial Economic Survey of US veterinarians included questions on financial aspects of veterinary practice operation in 1987.[1] Analysis of these survey data emphasized gross practice income, net practice income, returns to capital, labor, and management, cash operating expenses, and operating expense and financial ratios.

Practices were included in this analysis if: they employed at least 1 full-time equivalent veterinarian; they had been established for more than 1 year; they were operational 48 or more weeks in 1987; and they reported gross income, expense, and asset and liability data on the survey.

Practice income

Mean 1987 gross practice income was $263,914, up 7.6% from $245,287 in 1985 (Table 1).[2] Analysis by practice type showed that mean gross practice income ranged from a low of $219,008 for small animal predominant practice to a high of $374,053 for large animal predominant practice (Table 1). Mean gross practice income was $275,591 for equine practice, $292,940 for large animal exclusive, $256,583 for mixed animal, and $255,215 for small animal practice. A comparison of 1987 and 1985 data showed only slight changes in gross practice income for small animal practice and large increases for large animal practices. This is somewhat of a reversal of the trend in gross income seen from 1983 to 1985.[2] More specifically, from 1985 to 1987: large animal exclusive gross practice income increased 46%; large animal predominant was up 19%, mixed animal, up 10%; equine, up 12%; small animal predominant, down 0.3%; and small animal exclusive, up 4%.

Mean 1987 total practice expenses were computed as the sum of all cash operating expenses and employed (nonowner) veterinarian's earnings. Office rent was included in total practice expenses only if practice real estate was leased from other than a veterinarian involved in the practice. Mean total practice expense was $161,509, ranging from a low of $129,038 for small animal predominant to a high of $244,433 for large animal predominant practice (Table 1). Across all types of practice, mean total practice expenses were up 6% from 1985.

Net practice income for 1987 was determined by subtracting total practice expenses from gross practice income. For all practices, mean net practice income was $102,404, up 10%

Prepared by J. Karl Wise, PhD, Wisemark Associates, PO Box 681189, Schaumburg, IL 60168-1189.

This report is the third in a series of monthly Economic Notes summarizing results of the 1988 AVMA Biennial Economic Survey.

Table 1—Mean 1987 practice return ($) on capital, labor, and management

	Equine predominant	Large animal exclusive	Large animal predominant	Mixed animal	Small animal predominant	Small animal exclusive	All practices
Gross practice income	275,591	292,940	374,053	256,583	219,008	255,215	263,914
Total practice expenses*	168,946	173,729	244,433	159,401	129,038	154,889	161,509
Net practice income†	106,645	119,210	129,620	97,182	89,969	100,325	102,404
Return on capital‡	9,419	6,707	10,012	12,145	12,443	14,698	13,055
Return to labor and management§	97,226	112,503	119,607	85,037	77,526	85,628	89,349
Net practice income per owner‖	88,243	75,212	59,310	57,833	68,906	77,738	73,280
Return to labor and management per owner¶	79,527	70,732	53,836	49,040	58,614	65,291	62,696
Annual salary per owner#	45,271	51,450	45,233	41,946	43,995	51,993	48,854
Return to management per owner**	34,256	19,282	8,603	7,094	14,619	13,298	13,842
	(95)††	(80)	(182)	(143)	(230)	(208)	

*Total practice expenses include all cash operating expenses plus employed (nonowner) veterinarians' earnings, minus office rent if real estate was leased from veterinarians involved in the practice. †Net practice income equals the difference between gross practice income and total practice expenses. ‡Return on capital was computed as 12% of practice owners' equity. Equity equals the difference between the fair market value of practice fixed assets and long-term debt. §Return to labor and management was computed as net practice income less return on capital ‖ Net practice income per owner was computed by dividing net practice income by the number of full-time equivalent employed owners. ¶Return to labor and management per owner was computed by dividing return to labor and management by the number of full-time equivalent employed owners. # Annual 1987 salary reported by full-time employed practice owners. **Return to management per owner was computed as the residual profit, ie, the return to labor and management per owner less the imputed return to labor per owner (ie, mean salary per owner). ††Number of usable responses.

from 1985. On the average, net practice income represented 39% of gross practice income and showed a narrow range from 35% for large animal predominant practice to 41% for small animal predominant and large animal exclusive practice.

Net practice income includes return on capital invested, return to labor, and return to management. Return on capital invested was computed as 12% of practice equity or net worth. Equity equals the difference between the value of practice fixed assets and long-term debt. Return on capital invested represents a charge against practice income for the capital invested equal to the expected return if the capital were invested in its next best alternative use. Mean return on capital per practice was $13,055 (Table 1), ranging from $6,707 for large animal exclusive to $14,698 for small animal exclusive.

Return to labor and management was computed as net practice income less return on capital. The mean return to labor and management was $89,349, ranging from $77,526 for small animal predominant to $119,607 for large animal predominant (Table 1). On the average, return to labor and management was about 34% of gross practice income.

Income per owner

Net practice income per owner was computed by dividing net practice income by the full-time equivalent number of veterinarian-owners working in the practice. On the average, there were 1.4 owners per practice, ranging from 1.2 for small animal and equine to 2.0 for large animal predominant. The mean number of owners per practice for other practice types were as follows: 1.6, large animal exclusive; 1.7, mixed animal; and 1.3, small animal predominant. These data are nearly identical to data reported for 1985.[2]

Mean net practice income per owner in 1987 was $73,280, up 10% from 1985. It ranged from a low of $57,833 for mixed animal to a high of $88,243 for equine exclusive.

Return to labor and management per owner averaged $62,696, up 11% from 1985. It ranged from a low of $49,040 for mixed animal, up 11% from 1985, to a high of $79,527 for equine practice, up 34% from 1985. Again, in contrast to the period 1983 to 1985, large animal exclusive and equine practice showed strong gains from 1985 to 1987, while small animal practices showed only modest gains over the same period.

Return to labor represents the owner's time as a veterinarian. In this analysis, return to labor was chosen to equal the annual 1987 salary reported by full-time self-employed veterinarian-owners of practices. The national average owner's salary was $48,854 in 1987, up nearly 6% from 1985. Large animal exclusive practice owners reported substantially higher salaries in 1987 relative to 1985, while other practice owners reported only modest increases in salaries. For 1987, annual salaries for owners ranged from a low of $41,946 for mixed animal to a high of $51,993 for small animal exclusive.

Subtracting owner's salary from return to labor and management per owner yields the return to management per owner. Return to management represents anticipated entrepreneurial profit in excess of the expected return on capital and labor. The mean return to management per owner was $13,842 (Table 1). On the average, practices generated about 5% of gross practice income as return to management per owner, but this varied by practice, ranging from 2% to 12% in 1987.

Mean income vs median income

Mean and median 1987 gross practice incomes and returns to labor and management per owner were calculated (Table 2). Mean incomes, commonly called averages, were calculated for Tables 1 and 2 by summing all income values and dividing by the number of respondents. For comparison purposes, median incomes were calculated as the income level that divided the income distribution in half, ie, 50% of all veterinarians earning incomes below and 50% above this income level.

Table 2 shows that the median 1987 gross practice income was $202,881, roughly $60,000 less than the mean, or approximately 76% of the mean income value. This difference for 1987 is identical to the difference shown for 1985 data.[2] This difference between the mean and median highlights the fact that a few very high incomes offset many lower incomes to skew the mean upward.

The mean incomes reported in Table 1 are useful for comparisons across practice types and over time, but median incomes reported in Table 2 more accurately reflect the "typical" practice owner's income. Thus, the median return to labor and management for all practice owners in 1987 was $52,699, up

Table 2—Mean and median 1987 practice income ($) and mean number of veterinarians

	Gross practice income		Return to labor and management per owner		Veterinarians (mean)
	Mean	Median	Mean	Median	
Equine predominant	275,591	164,000	79,527	58,208	1.8
Large animal exclusive	292,940	210,000	70,732	65,864	2.1
Large animal predominant	374,053	288,500	53,836	50,315	2.5
Mixed animal	256,583	211,000	49,040	43,297	2.3
Small animal predominant	219,008	164,000	58,614	48,600	1.7
Small animal exclusive	255,215	200,700	65,291	54,174	1.7
All practices	263,914	202,881	62,696	52,699	1.8

Table 3—Mean 1987 gross practice income ($) and gross practice income ($) per veterinarian, by number of veterinarians

No. of veterinarians	Equine predominant	Large animal exclusive	Large animal predominant	Mixed animal	Small animal predominant	Small animal exclusive
1 (1 to 1.5)*	142,248†	139,992	136,035	132,190	137,741	160,119
	138,397‡	139,364	133,486	128,102	132,378	151,806
2 (1.6 to 2.5)	266,507	251,935	330,323	229,913	253,179	329,272
	133,253	125,058	163,031	114,827	123,888	158,919
3 (2.6 to 3.5)	543,218	439,941	476,007	369,567	353,476	361,677
	182,614	146,647	155,969	119,599	116,333	119,828
4 (3.6 to 4.5)	759,633	593,410	547,732	441,592	545,811	618,419
	180,084	145,380	136,031	109,557	132,703	154,604
≥5 (≥4.6)	1,067,803	811,244	934,670	663,000	821,636	923,708
	167,161	154,915	153,014	99,613	153,135	161,268
All practices	275,591	292,940	374,053	256,583	219,008	255,215
	144,899	138,261	147,676	118,843	127,913	149,313
	(95)§	(80)	(182)	(143)	(230)	(208)

*Numbers in parentheses represent the range of full-time equivalents. For purposes of discussion in the text, the range of 1 to 1.5 will be referred to as a 1-veterinarian practice, and 1.6 to 2.5 as a 2-veterinarian practice, etc. †1987 mean gross practice income. ‡1987 mean gross practice income per veterinarian. §No. of usable responses.

8.7% from $48,479 in 1985.

Practice mean and median income values in Table 2 are associated with mean number of veterinarians per practice. Overall, the mean number of veterinarians was 1.8, and ranged from 1.7 in small animal practice to 2.5 for large animal predominant practice.

Practice income and number of veterinarians

To provide a perspective on the relationship between gross practice income and number of veterinarians, the sample of practices was divided into 5 classes according to the number of veterinarians in the practice (1, 2, 3, 4, or 5).

In 1987, gross practice income per veterinarian ranged from $118,843 for mixed animal practice to $149,313 for small animal exclusive (Table 3). In general, 1-veterinarian practices generated between $130,000 and $160,000/yr, depending on practice type, 2-veterinarian practices generated $250,000 to $330,000/yr, and 3-veterinarian practices generated $350,000 to $540,000/yr.

Regarding gross revenue per veterinarian, small animal predominant and exclusive practices showed gains of 5% and 9%, respectively, from 1985 to 1987.[2] Mixed animal and equine practice gross revenues per veterinarian gained 10% and 11%, respectively, over the same 2-year period. It was in the agricultural sector that large animal veterinarians made substantial gains in gross revenue generated per veterinarian, increasing 18% for large animal predominant and 30% for large animal exclusive from 1985 to 1987.

Practice expenses

Veterinary practice owners reported 1987 cash expenditures for 21 practice expense items (Table 4). Mean annual

Table 4—Mean 1987 practice cash expenses ($), by type of practice

Expense item*	Equine predominant	Large animal exclusive	Large animal predominant	Mixed animal	Small animal predominant	Small animal exclusive	All practices
Employed (nonowner) veterinarian wages	59,018	36,111	41,485	37,368	27,429	28,163	31,949
Nonprofessional staff wages	28,861	19,499	29,508	28,611	32,269	44,662	38,033
Payroll taxes	9,208	10,892	9,341	8,968	8,012	10,168	9,622
Drugs and hospital supplies	54,076	86,153	132,038	70,236	41,628	38,926	53,873
Office supplies	4,129	2,470	4,191	4,146	4,148	4,309	4,168
Office rent	6,759	5,095	8,818	7,611	9,248	16,807	13,079
Equipment rental	4,558	4,484	2,106	3,592	3,029	4,764	4,103
Auto expense	7,661	9,612	9,563	5,660	3,167	2,367	4,041
Utilities and telephone	5,982	4,505	5,313	6,128	5,485	7,068	6,398
Laboratory fees	4,451	2,759	3,801	2,639	3,088	5,542	4,575
Property taxes	1,901	1,734	1,773	1,960	1,695	2,442	2,159
Licenses, permits, dues, subscriptions	1,228	1,272	1,312	1,089	1,178	1,357	1,295
Building and equipment repair and maintenance	1,965	1,879	2,423	2,581	2,605	3,018	2,755
Accounting and legal	2,483	1,958	2,124	1,715	1,589	2,358	2,150
Insurance	7,021	6,591	6,505	5,954	4,655	5,614	5,683
Interest	6,147	3,904	5,367	6,523	6,384	7,539	6,828
Continuing education and travel	2,228	1,953	1,735	1,347	1,203	1,628	1,592
Disposal	1,006	454	576	794	801	1,062	921
Feed	3,423	4,407	4,577	1,962	3,561	4,060	3,850
Pension and profit-sharing (nonowners)	6,205	8,340	9,992	4,665	7,004	5,407	6,225
Miscellaneous	7,946	4,195	5,193	5,359	5,997	7,992	7,020

*Includes only practices incurring an expense for each item; missing values and zero expenses were excluded.

Table 5—Mean 1987 practice cash expenses as a percentage of total practice expenses and gross practice by revenue, by type of practice

Expense item*	Equine predominant		Large animal exclusive		Large animal predominant		Mixed animal		Small animal predominant		Small animal exclusive		All practices	
	% of total expenses	% of gross revenue	% of total expenses	% of gross revenue	% of total expenses	% of gross revenue	% of total expenses	% of gross revenue	% of total expenses	% of gross revenue	% of total expenses	% of gross revenue	% of total expenses	% of gross revenue
Employed (nonowner) veterinarian wages	18.4	13.4	14.9	9.6	13.2	9.4	15.1	10.9	14.0	9.5	12.5	8.5	13.4	9.2
Nonprofessional staff wages	15.0	10.5	12.1	7.4	12.9	8.1	17.5	11.1	22.9	14.4	26.0	17.0	22.4	14.5
Payroll taxes	5.3	3.4	4.9	2.9	4.0	2.4	5.0	3.3	5.2	3.4	5.9	3.9	5.4	3.6
Drugs and hospital supplies	39.3	25.0	50.1	29.1	55.0	35.7	43.9	27.9	34.0	21.0	27.9	17.5	34.3	21.6
Office supplies	3.2	1.9	2.1	1.2	2.3	1.4	2.7	1.7	3.6	2.5	3.0	1.9	3.0	1.9
Office rent	6.7	5.7	4.2	2.4	3.3	2.2	5.9	4.0	10.8	6.8	11.5	7.5	9.6	6.3
Equipment rental	3.6	2.3	2.6	1.4	2.4	1.2	2.3	1.4	2.5	1.6	2.4	1.6	2.5	1.6
Auto expense	7.4	5.1	8.3	4.4	5.5	3.1	4.3	2.7	3.4	2.0	2.2	1.4	3.4	2.1
Utilities and telephone	4.8	3.2	3.9	2.0	3.1	1.9	4.4	2.9	5.0	3.1	5.2	4.9	4.8	3.9
Laboratory fees	3.6	2.3	2.1	1.1	1.4	0.9	1.7	1.0	2.1	1.4	3.3	2.1	2.8	1.7
Property taxes	1.6	0.9	1.2	0.6	1.1	0.7	1.4	0.9	1.6	1.0	1.9	1.2	1.7	1.1
Licenses, permits, dues, subscriptions	1.3	0.8	1.2	0.6	0.7	0.4	0.9	0.6	1.1	0.7	1.1	0.7	1.1	0.7
Building and equipment repair and maintenance	2.1	1.4	1.2	0.6	1.3	0.8	1.8	1.1	2.5	1.5	2.3	1.4	2.1	1.3
Accounting and legal	2.0	1.3	1.2	0.7	1.0	0.6	1.2	0.7	1.4	0.8	1.6	1.0	1.5	0.9
Insurance	5.3	3.4	4.4	2.5	3.1	1.9	4.2	2.6	3.9	2.4	3.6	2.2	3.8	2.3
Interest	4.3	2.7	3.4	2.1	3.3	2.2	4.8	3.1	5.7	3.8	5.5	3.6	5.1	3.3
Continuing education and travel	1.9	1.2	1.7	0.8	0.9	0.6	1.0	0.6	1.2	0.7	1.2	0.7	1.2	0.7
Disposal	0.6	0.3	0.3	0.2	0.2	0.1	0.5	0.3	0.6	0.4	0.6	0.4	0.5	0.3
Feed	2.2	1.5	2.2	1.3	1.9	1.2	1.6	1.1	2.3	1.5	2.5	1.6	2.3	1.5
Pension and profit-sharing (nonowners)	3.2	2.2	3.8	2.4	2.9	1.9	2.2	1.4	3.4	2.0	2.6	1.5	2.8	1.7
Miscellaneous	5.7	4.0	3.1	1.8	1.9	1.3	3.2	2.2	4.7	3.5	4.5	3.0	4.2	2.8

*Includes only practices incurring an expense for each item; missing values and zero expenses were excluded.

Table 6—Median 1987 veterinary practice financial ratios

	Equine predominant	Large animal exclusive	Large animal predominant	Mixed animal	Small animal predominant	Small animal exclusive	All practices
Return to labor and management: gross practice income	0.35	0.40	0.32	0.33	0.34	0.32	0.33
Total practice debt: total practice assets	0.29	0.29	0125	0.22	0.37	0.31	0.30
Total practice debt: practice net worth	0.54	1.10	0.71	0.52	0.69	0.59	0.63
Current assets: current liabilities	3.00	4.83	2.50	2.60	1.83	2.50	2.52
Drug and hospital supply expense: drug and hospital supply inventory	4.47	4.51	3.66	3.15	4.00	4.36	4.15

expense for each expense item was determined by practice type for those practices incurring a particular expense.

With the exception of small animal exclusive, drugs and hospital supply expenses represented the greatest expense item, ranging from $38,926 for small animal exclusive to $132,038 for large animal predominant practice. While equine and small animal practice sectors showed little increase or even a slight decline in drug and hospital supply expenses from 1985 to 1987, large animal practices showed large increases in this expense category: large animal exclusive, up 36%; large animal predominant, up 19%, and mixed animal practice, up 21%.

Operating expense ratios or percentages also were developed for the 21 practice expense items (Table 5). For each practice, each expense was divided by total practice expenses and then by gross practice income. Missing values or zero expenditures for a particular expense were not included in the computation of the percentage for that particular expense item. For this reason, the sum of all operating expense percentages for a particular practice type equals more than 100%.

Operating expense ratios showed little change from 1985.[2] Drugs and hospital supply expenses remained at approximately 30% and 35% for large animal exclusive and large animal predominant, respectively. Likewise, ratios were stable in the small animal practice sector.

Financial ratios

Five financial ratios were computed to examine the relationship of certain financial variables to one another (Table 6). Ratios presented here are not absolute criteria for operating performance, but rather represent industry benchmarks or averages.

As a measure of profitability, the median ratio of practice owner's return to labor and management to gross practice income was determined to be 0.33, showing no change from 1985. This means that, on the average, after deducting all practice expenses, including an expected return on capital invested (owners' equity) in the practice, practice owners' net income before personal taxes from practice was 33% of gross practice income. Stated another way, for every dollar of gross practice receipts generated in 1987, 33 cents was net income to the practice owner(s). Across practice types, the ratio varied from a low of 0.32 for small animal exclusive and large animal predominant to a high of 0.40 for large animal exclusive.

As a measure of long-run solvency, the median ratio of total practice debt to total practice assets was estimated to be 0.30, down from 0.34 in 1985 and 0.39 in 1983.[2,3] This ratio is useful to creditors, because it indicates the proportion of practice assets that are financed outside the practice. Much of the decline in this ratio is attributable to a decrease from 0.38 in 1985 to 0.31 in 1987 for small animal exclusive, and from 0.33 in 1985 to 0.22 in 1987 for mixed animal practice. Large animal exclusive practice total debt to total assets ratio was unchanged from 1987.

Another measure of long-run solvency is total practice debt to practice net worth, or owner's equity. If this ratio is greater than 1.0, then external debt is greater than owner's equity and, from a creditor's point of view, the practice may be undercapitalized. In 1987, this ratio was 0.63, compared to 0.65 in 1983, suggesting that owners are not highly leveraged through outside financing.

A measure of a practice's ability to meet short-term debts is the acid-test or quick ratio. The acid-test ratio relates current assets (ie, cash, short-term marketable securities, and accounts receivable) to total current liabilities (ie, accounts payable and notes payable in 1 year). The median acid-test ratio of current assets to current liabilities was 2.52 in 1987, up from 2.08 in 1985. Ratios were up from 1985 for all practice types, except large animal predominant and small animal predominant.

Inventory turnover ratio measures how many times a practice's inventory has been depleted during the year. Median inventory ratio was computed by dividing drugs and hospital supply expenses by the value of drugs and hospital supply inventory. In 1985, the ratio was 4.15, nearly equal to the 4.04 ratio in 1985.

---

1. Wise JK. 1987 incomes of US veterinarians. *J Am Vet Med Assoc* 1989; 194:563-566.
2. Wise JK. 1985 US veterinary practice income, expenses, and financial ratios. *J Am Vet Med Assoc* 1987; 190:1594-1598.
3. Wise JK. 1983 US veterinary practice income, expenses, and financial ratios. *J Am Vet Med Assoc* 1985;186:605-608.

A3100-2
5/18/89

May 15, 1989, Volume 194, Number 10

JOURNAL OF THE AMERICAN VETERINARY MEDICAL ASSOCIATION

Research Roundup
The ominous spread of *Borrelia burgdorferi* infection 1387

Borrelia burgdorferi infection in horses (letter) 1384

AVMA at Work
Preview of AVMA-funded drug residue study 1392

Economic Note
Trends in veterinarians' incomes, 1980 to 1987 1474

Side effects of etomidate in dogs 1450

Clinical features of salmonellosis in cats 1464

800185262 1 051589 2 23
CONGRESSIONAL INFO SERV
MR ED KIANKA STAT REF INDEX
4520 EAST WEST HWY
BETHESDA MD 20814

3

BEST AVAILABLE COPY

JOURNAL
OF THE AMERICAN VETERINARY MEDICAL ASSOCIATION

American Veterinary Medical Association, 1989
All Rights Reserved

Vol 194 May 15, 1989 No. 10
JAVMA 194(10) 1377-1512 (1989)
ISSN 0003-1488

Interpretive Summaries of Articles in This Issue 1380

Letters

Borrelia burgdorferi infection in horses 1384
Chemical restraint for true evaluation of hip status in dogs 1385

News

Research Roundup—The ominous spread of *Borrelia burgdorferi* infection 1387
$1 million grant funds study of BIV as model for AIDS 1391
AVMA at Work—Preview of AVMA-funded drug residue study 1392
Specialty Board recognizes emergency medicine, critical care 1397
AVMA and Canadian VMA reconfirm examination reciprocity 1398
Practice Management Corner 1393
Edge of Education—Changing environments and external factors that may impact veterinary medicine 1394
Coast to Coast 1399
Student and School Scenes—Enrollment decline continues in 1988-1989 1400
Pages from the Past—Leeches and leeching: the magic cure 1402
Proposed amendments to AVMA Constitution and Bylaws 1404

The *Human* Side of Veterinary Medicine

Hagglers, slow payers, and no payers—*Jacob Antelyes* 1412

Special Commentary

Breath sound terminology in the veterinary literature—*Philip Roudebush and Jean Ryan* 1415

Food Animal Economics

Cost of mastitis and its prevention in four dairy cattle herds on St Croix, US Virgin Islands—*A. S. Ahl, C. D. Gibson, J. H. Kirk, J. B. Kaneene, and J. G. Ahl* 1418

Reports of Original Studies

Bovine fetal infection with *Mycobacterium paratuberculosis*—*Susan E. Seitz, Lawrence E. Heider, William D. Hueston, Steen Bech-Nielsen, D. Michael Rings, and Liz Spangler* 1423

Prevalence of leukemic blood and bone marrow in dogs with multicentric lymphoma—*Rose E. Raskin and Janver D. Krehbiel* 1427

Side effects of etomidate in dogs—*William W. Muir and Diane E. Mason* 1430

Clinical Reports

Treatment of proliferative colitis in ferrets—*Karen L. Krueger, James C. Murphy, and James G. Fox* 1435

Zygomatic salivary gland mucocele in a ferret—*Paul E. Miller and J. Phillip Pickett* 1437

Cerebrospinal nematodiasis in a goat herd—*M. Kopcha, J. V. Marteniuk, R. Sills, B. Steficek, and T. W. Schillhorn van Veen* 1439

Malignant fibrous histiocytoma in a cat—*K. L. Gibson, C. E. Blass, M. Simpson, and S. D. Gaunt* 1443

Triploidy (117,XXX) in a stillborn canine pup conceived with frozen semen—*Shirley D. Johnston, Lance C. Buoen, Alvin F. Weber, and Tsang-Long Lin* 1446

Obstructed portal venous flow and portal vein thrombus in a dog—*M. D. Willard, M. Q. Bailey, J. G. Hauptman, and T. Mullaney* 1449

Extraskeletal osteosarcoma in two dogs—*Charles J. Schena, Russ L. Stickle, Robert W. Dunstan, Allan L. Trapp, Keith A. Reimann, Jerry V. White, Cheryl R. Killingsworth, and J. G. Hauptman* 1452

Thrombocytosis associated with a myeloproliferative disorder in a dog—*Melisa A. Degen, Bernard F. Feldman, Jane M. Turrel, Bud Goding, Barbara Kitchell, and Carol P. Mandell* 1457

Reports of Retrospective Studies

Prognostic factors and survival after radiotherapy for intranasal neoplasms in dogs: 70 cases (1974-1985)—*Sydney M. Evans, Michael Goldschmidt, Linda J. McKee, and Colin E. Harvey* 1460

Clinical features of salmonellosis in cats: Six cases (1981-1986)—*Steven W. Dow, Robert L. Jones, Rosemary A. Henik, and Paul W. Husted* 1464

Clinical, radiographic, and bronchial cytologic features of cats with bronchial disease: 65 cases (1980-1986)—*N. Sydney Moise, Dayna Wiedenkeller, Amy E. Yeager, Julia T. Blue, and Janet Scarlett* 1467

Economic Note

Trends in veterinarians' incomes, 1980 to 1987—*J. Karl Wise* 1474

What Is Your Diagnosis?

Rebecca S. McConnico, Ann M. Rashmir, and James P. Douglass 1477

Book Reviews

Bovine Radiology 1436
Newcastle Disease 1442
Equine Lameness 1456
Books received but not reviewed 1426

Announcements

Coming Meetings 1480
Foreign Meetings 1484
Applications for Membership 1485
Certification Examinations 1486
State Board Examinations 1486
Educational Opportunities 1488

Classified Ads 1493

Coming Soon . . .

June 1 issue

Special Commentary—Titers, tests, and truisms: Rational interpretation of diagnostic serologic testing (J. T. Tyler and J. S. Cullor)

Topics in Drug Therapy—L-Asparaginase for treatment of lymphoid neoplasia in dogs (K. S. Rogers)

Letter—Taking a hard look at *Borrelia burgdorferi*

Efficacy of zinc citrate ascorbate for treatment of canine cataracts (A. D. Mac Millan et al)

Hypokalemia in cats (S. W. Dow et al)

June 15 issue

Research Roundup—Equine monocytic ehrlichiosis

Treatment of canker in horses (D. G. Wilson et al)

Comparison of four screening techniques for the diagnosis of equine neonatal hypogammaglobulinemia (D. L. Clabough et al)

Laryngeal paralysis in immature and mature dogs as one sign of a more diffuse polyneuropathy (K. G. Braund et al)

Blue-green algae (*Anabaena spiroides*) toxicosis in pigs (M. M. Chengappa et al)

Abstracts of scientific papers to be presented at the 1989 AVMA meeting

Student and School Scenes

Enrollment decline continues in 1988-1989

Total enrollment in DVM/VMD-degree programs in the United States and Canada continued to decrease in the 1988-1989 academic year. Enrollment dropped by 136 students, compared with 114 in 1987-1988. The decline continued despite the 41-student increase in Canadian enrollment, the result of another class entering the developing program at the University of Prince Edward Island. For the 1988-1989 academic year, 9,718 students were enrolled (Table 1), including 8,574 in the US colleges and 1,144 in the Canadian colleges.

Statistical information provided by the Association of American Veterinary Medical Colleges indicates that freshman enrollment declined by 12 students in the 27 US veterinary colleges, less than the decline of 66 in the preceding year, and increased by 3 in the Canadian colleges.

Of the total US and Canadian enrollment in DVM-degree programs, female students outnumber male students 57.5% to 42.5% (Table 1), a trend that began in the 1985-1986 academic year.

Total enrollment in US and Canadian graduate-degree and certificate programs in 1988-1989 is 2,738 (Table 2), up by 229 participants or 9% over 1987-1988. The 1988-1989 total includes 1,656 with and 1,082 without DVM or VMD degrees or their equivalent.

Enrollment by class year is presented in Table 3, and geographic distribution of first-year students in the US veterinary colleges is shown in Table 4.

Prepared by Carole S. Jordan, AVMA Division of Scientific Activities, staff writer.

TABLE 1—Total enrollment in veterinary medical degree programs

	Male		Female		
	No.	(%)	No.	(%)	Total
United States	3,649	(43)	4,925	(57)	8,574
Canada	476	(42)	668	(58)	1,144
Total	4,125	(42.5)	5,593	(57.5)	9,718

TABLE 2—Total enrollment in US and Canadian graduate-degree and certificate programs

Graduate	MS	PhD	Certificate of internship	Certificate of residency	Certificate of residency and MS	Certificate of residency and PhD	Total
DVM	439	619	123	216	172	87	1,656
Non-DVM	526	556	—	—	—	—	1,082
Total	965	1,175	123	216	172	87	2,738

TABLE 3—Total enrollment of veterinary medical degree students by class year

College	1st Year	2nd Year	3rd Year	4th Year	Total
Auburn University	92	89	87	76	344
California, University of	123	122	116	123	484
Colorado State University	130	122	125	121	498
Cornell University	80	82	75	77	314
Florida, University of	80	85	74	77	316
Georgia, University of	84	72	80	78	314
Illinois, University of	87	77	84	72	320
Iowa State University	74	94	102	106	376
Kansas State University	100	91	94	93	378
Louisiana State University	64	65	79	75	283
Michigan State University	96	98	96	102	392
Minnesota, University of	67	62	69	77	275
Mississippi State University	43	41	44	28	156
Missouri, University of	64	68	69	70	271
North Carolina State University	70	70	65	71	276
The Ohio State University	129	131	123	125	508
Oklahoma State University	70	69	68	69	276
Oregon State University	36	*	*	36	72
Pennsylvania, University of	107	105	105	103	420
Purdue University	60	62	56	58	236
Tennessee, University of	60	61	56	0	177
Texas A&M University	128	110	126	123	487
Tufts University	74	62	62	62	260
Tuskegee University	59	56	40	47	202
Virginia Polytechnic University	78	80	78	78	314
Washington State University	58	98	97	71	324
Wisconsin, University of	82	77	68	74	301
Total-US Colleges	2,195	2,149	2,138	2,092	8,574
Guelph, University of	102	100	100	124	426
Montreal, University of	74	72	74	75	295
Saskatchewan, University of	71	71	71	68	281
Atlantic Veterinary College	47	47	48	0	142
Total-Canadian Colleges	294	290	293	267	1,144
Total-US & Canadian Colleges	2,489	2,439	2,431	2,359	9,718

*Oregon State University veterinary students spend their second year and part of their third year at Washington State University. Therefore, Oregon State's 35 second-year and 35 third-year students are included in Washington State's figures.

TABLE 4—Geographic distribution of entering class of veterinary students in US colleges

	UNIVERSITIES																											
Residence	Auburn	California	Colorado	Cornell	Florida	Georgia	Illinois	Iowa	Kansas	Louisiana	Michigan	Minnesota	Mississippi	Missouri	North Carolina	Ohio	Oklahoma	Oregon	Pennsylvania	Purdue	Tennessee	Texas A&M	Tufts	Tuskegee	Virginia Polytechnic	Washington	Wisconsin	Total
Alabama	46	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	1	...	...	1	...	...	...	49
Alaska	...	...	3	...	...	...	...	...	1	...	...	...	...	...	...	...	...	2	...	...	...	...	...	...	...	2	...	8
Arizona	...	1	15	...	1	...	...	...	1	...	...	1	...	...	1	1	...	1	...	1	...	...	...	...	...	1	...	24
Arkansas	...	...	...	...	...	...	...	...	...	19	...	...	...	6	...	...	2	...	...	1	...	...	...	3	...	...	...	31
California	1	116	3	...	...	1	2	1	2	...	4	...	3	...	...	...	2	...	1	...	1	...	2	4	...	5	5	153
Colorado	...	...	60	...	...	...	...	...	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	63
Connecticut	1	...	...	3	1	...	2	...	1	...	1	1	...	...	...	...	1	...	2	1	...	...	5	...	...	...	2	21
Delaware	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2	...	...	...	...	1	...	...	...	4
District of Columbia	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	0
Florida	2	...	...	1	73	...	...	...	...	...	...	1	...	...	...	...	...	...	...	1	...	...	2	2	...	...	2	84
Georgia	1	...	...	...	...	56	...	...	...	...	...	...	2	...	...	...	...	...	1	...	...	...	...	4	...	...	...	64
Hawaii	...	1	3	...	...	...	...	...	1	...	...	...	...	...	...	1	...	1	...	...	...	...	...	1	...	1	1	10
Idaho	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	12	...	12
Illinois	...	...	...	...	...	...	79	...	1	...	1	1	...	...	...	...	...	...	2	2	...	...	...	1	...	...	...	87
Indiana	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	41	...	...	...	...	...	...	...	42
Iowa	...	...	...	...	...	...	...	60	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	60
Kansas	...	...	...	...	...	...	...	...	50	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	50
Kentucky	36	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	1	...	...	...	38
Louisiana	...	...	...	...	...	...	...	...	...	43	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	44
Maine	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	2	...	...	...	...	4
Maryland	...	...	...	2	...	...	...	...	...	...	1	...	1	...	...	4	...	...	4	...	...	...	...	4	...	28	...	44
Massachusetts	...	...	...	...	1	...	...	...	...	...	2	4	...	...	...	1	...	1	...	...	...	...	42	...	...	...	...	51
Michigan	1	...	...	...	...	...	...	...	...	...	82	1	1	...	...	...	...	...	...	1	...	...	...	2	...	...	...	88
Minnesota	37	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	38
Mississippi	...	...	...	...	...	...	...	...	...	...	...	...	25	...	...	...	...	...	...	...	...	...	...	1	...	...	...	26
Missouri	...	...	...	...	...	...	1	...	...	...	...	...	...	55	...	...	...	...	...	...	...	...	...	...	...	...	...	56
Montana	...	1	6	...	...	...	...	...	...	...	...	1	...	...	...	...	...	1	...	...	...	...	...	...	...	2	...	11
Nebraska	...	...	...	...	...	...	...	...	35	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	36
Nevada	...	1	2	...	...	1	...	...	...	...	...	1	...	1	...	2	...	1	...	...	...	...	...	...	...	2	...	11
New Hampshire	...	...	...	...	...	...	...	...	1	...	...	1	...	...	...	4	...	...	1	...	...	...	3	...	...	...	...	10
New Jersey	...	...	...	7	1	...	...	...	1	...	2	...	2	1	1	4	1	...	16	4	2	...	4	2	1	...	1	50
New Mexico	...	1	16	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	18
New York	1	...	...	64	1	...	1	1	...	...	...	7	4	...	...	2	1	...	1	2	6	...	10	4	...	...	1	106
North Carolina	1	...	...	...	...	...	1	...	...	...	...	...	...	...	65	1	...	...	...	...	...	...	...	2	...	...	...	70
North Dakota	...	...	4	...	...	...	...	5	1	...	...	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	13
Ohio	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	97	...	...	...	1	...	...	...	2	...	...	...	101
Oklahoma	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	63	...	...	...	...	...	...	...	...	...	...	63
Oregon	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	28	...	...	...	...	...	...	...	...	...	29
Pennsylvania	...	...	...	...	...	...	...	2	...	...	2	3	1	...	...	3	...	...	70	2	4	...	...	2	...	...	2	91
Puerto Rico	...	...	...	...	1	...	...	2	1	2	1	...	...	...	...	1	...	...	1	...	...	...	...	5	...	...	...	14
Rhode Island	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	1	1	...	...	...	...	4
South Carolina	...	...	...	...	...	17	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	2	...	...	...	20
South Dakota	...	...	...	...	...	...	...	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2
Tennessee	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	41	...	...	...	...	...	...	41
Texas	1	...	...	...	...	...	...	...	1	...	...	...	1	...	...	...	...	...	...	1	...	128	...	1	...	...	...	133
Utah	1	2	12	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	1	...	...	...	...	...	...	...	17
Vermont	...	...	...	1	...	...	...	...	...	...	...	...	...	...	1	...	...	...	3	...	1	...	...	...	...	...	...	6
Virginia	...	...	...	...	1	1	...	...	1	...	...	...	2	...	...	...	...	...	1	...	1	...	1	1	50	...	...	59
Washington	...	...	...	...	...	...	...	...	...	...	...	1	...	...	1	...	...	...	...	...	...	...	...	1	...	32	...	35
West Virginia	...	...	...	...	...	7	...	...	...	...	...	...	...	...	...	5	...	...	...	...	...	...	...	...	...	...	...	12
Wisconsin	...	...	...	...	...	...	...	...	...	...	...	3	...	...	...	...	...	...	1	...	...	...	...	...	...	...	66	70
Wyoming	...	...	6	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	1	...	8
Dominica	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	1
France	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	1
Israel	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	1
Jamaica	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	3	...	...	...	3
Sweden	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	1
Trinidad	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	3	...	...	...	3
Venezuela	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	1
Virgin Islands	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	1
West Indies	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2	...	...	...	2
TOTAL	129	123	130	80	80	84	86	74	100	64	96	30	43	64	70	129	70	37	107	60	58	129	74	59	51	86	82	2,195

Economic Note

Trends in veterinarians' incomes, 1980 to 1987

On the basis of surveys conducted by the AVMA, the mean professional income of US veterinarians increased from $41,034 in 1983 to $47,858 in 1987, an increase of 16.6% over the 4-year period, or a compounded annual increase of 3.9%.[1,2] Table 1 shows mean incomes and the percentage change for this period for each type of private and nonprivate practice employment.

Private practitioners' mean income increased 17.7% from $39,669 in 1983 to $46,692 in 1987. Large animal exclusive practitioners had the largest gain, increasing by 29.6%. Small animal practitioners showed gains of 21 to 22%, whereas equine and mixed animal practitioners showed gains of 16 to 18%. Large animal predominant practitioners' mean professional income increased 11.1% over the 4-year period.

In nonprivate practice, mean veterinarian income increased 14.5%, from $45,393 in 1983 to $51,995 in 1987. Armed forces veterinarians and state or local government veterinarians showed the highest percentage gain with 18.8% and 20.2%, respectively. College or university veterinarians' mean income increased 14.0%, while federal government and industry or other veterinarians showed gains of 7.2% and 9.8%, respectively.

Table 1—Money and real incomes of veterinarians, 1983-1987

	Money income			Real income*	
	1983 ($)	1987 ($)	Percentage change, 1983-1987 (%)	1987 (1983 dollars)	Percentage change, 1983-1987 (%)
Private practice†					
Large animal exclusive	42,168	54,659	29.6	47,904	13.6
Large animal predominant	41,530	46,149	11.1	40,446	−2.6
Mixed animal	35,169	40,796	16.0	35,755	1.7
Small animal predominant	35,805	43,784	22.3	38,373	7.2
Small animal exclusive	38,683	46,866	21.2	41,074	6.2
Equine	48,300	57,196	18.4	50,128	3.8
Total	39,669	46,692	17.7	40,922	3.2
Nonprivate practice					
College or university	44,513	50,739	14.0	44,469	−0.1
Federal government	42,431	45,477	7.2	39,857	−6.1
State or local government	37,854	45,500	20.2	39,877	5.3
Armed forces	36,515	43,365	18.8	38,006	4.1
Industry or other	55,784	61,249	9.8	53,680	−3.8
Total	45,393	51,995	14.5	45,570	0.4
All veterinarians	41,034	47,858	16.6	41,944	2.2

*Money income expressed in 1983 dollars, ie, correcting for the increased cost of living measured by the consumer price index (all urban consumers). †Includes veterinarian-owners and veterinarian-employees in private practice; owners' income excludes return on equity in practice real estate.

It is important to determine the extent of increase or decrease in veterinarians' purchasing power by taking into account the effect of price changes. The most widely used measure of changes in prices at the retail level is the consumer price index for all urban consumers. The consumer price index is sometimes referred to as the cost-of-living index.

To analyze veterinarians' professional incomes in real terms, ie, correcting for the increased cost of living, professional incomes for 1987 were expressed in 1983 dollars. The consumer price index increased 14.1% from 1983 to 1987. Therefore in real terms, the mean professional income of veterinarians increased 2.2% from 1983 to 1987. Whereas previous survey data documented a 1.6% decline in real income from 1983 to 1985, professional incomes improved from 1985 to 1987.

Mean real nonprivate practice income increased 0.4%, while mean real private practice professional income increased 3.2% over the 4-year period. Federal government, industry, and food animal practice suffered declines in real income of 2% to 6% from 1983 to 1987.

On the basis of the 1985 AVMA manpower study, mean real private practice net individual income was projected to decline by the year 2000 to 75% of its value in the year 1980.[3] Most of the decline was projected to occur by 1990 as mean real pri-

---

Prepared by J. Karl Wise, PhD, Wisemark Associates, PO Box 681189, Schaumburg, IL 60168-1189.

This report is the fourth in a series of monthly Economic Notes summarizing results of the 1988 AVMA Biennial Economic Survey.

vate practice income would fall to 82% of its 1980 level by the year 1990 (Fig 1). From 1980 to 1990 this would represent an 18% decline in projected real income. It was stated in the manpower study synopsis that the impact would be less for some established practitioners than for new veterinarians, but all practitioners would be affected. Specifically, it was believed that the impact of the projected decline would be reflected initially in depressed entry-level salaries, followed by lower overall mean real incomes in subsequent years.

Table 2 shows money and real mean incomes for specific years from 1980 to 1988 for new veterinarians and private practice owners.[4] Starting salaries increased 24% in money terms, but declined 13% in real terms. Figure 1 reveals that, in real terms, starting salaries have neither gained nor lost purchasing power since 1984.

From 1980 to 1987, private practice owners' mean professional income increased by 48% in money terms, 10 percentage points more than the 38% increase in the consumer price index. From 1980 to 1983, mean real income of practice owners declined by 6%, but has rebounded to a level in 1987 that is 7% greater than that of 1980. These data suggest that, to date, real veterinary practice incomes have not declined as projected in the 1985 AVMA manpower study.

Factors most likely associated with the improvement in real incomes since 1983 are continued expansion in the national economy, expansion in specific veterinary service markets such as feline care, diagnostic testing, embryo transfer, and product sales, and implementation of aggressive public education and marketing activities throughout the profession.

At the time of the AVMA manpower study, available economic data for the nation and specific veterinary markets did not suggest current trends. Also, and perhaps, more importantly, public education about animal health and marketing activities by veterinary practitioners throughout the nation were initiated on the heightened awareness and knowledge that if the profession did not make major changes to expand veterinary service markets, the projected decline in practitioners' economic well-being was probable.

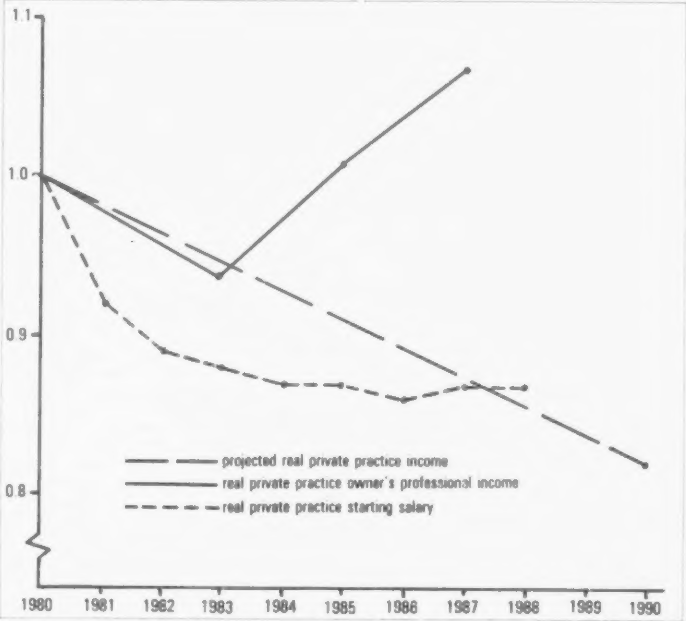


Figure 1—Standardized trends in private practice income (1980 = 1.0).

Table 2—Money and real incomes in private practice, 1980-1988

	1980 ($)	1983 ($)	1985 ($)	1987 ($)	1988 ($)
Private practice starting salary					
Money income	18,552	19,872	20,956	22,152	23,079
	(1.00)*	(1.07)	(1.13)	(1.19)	(1.24)
Real income†	22,433	19,872	19,421	19,427	19,443
	(1.00)	(0.89)	(0.87)	(0.87)	(0.87)
Private practice owners' professional income‡					
Money income	38,755	44,249	51,064	57,303	...
	(1.00)	(1.14)	(1.32)	(1.48)	...
Real income	46,862	44,249	47,281	50,222	...
	(1.00)	(0.94)	(1.01)	(1.07)	...

*Numbers in parentheses are standardized values (1983 = 1.00) to indicate change in money and real incomes over time. †Money income expressed in 1963 dollars, ie, correcting for the increased cost of living measured by the consumer price index (all urban consumers). ‡Excludes owners' economic return on equity in practice real estate.

References

1. Wise JK. Trends in veterinarians' incomes. *J Am Vet Med Assoc* 1987;191:465–466.

2. Wise JK. 1987 Professional incomes of US veterinarians, by hours worked and years since graduation. *J Am Vet Med Assoc* 1989;194:815–817.

3. Wise JK, Kushman JE. Synopsis of US veterinary medical manpower study: demand and supply from 1980 to 2000. *J Am Vet Med Assoc* 1985;187:358–361.

4. Wise JK. Trend in real starting salaries of US veterinary medical college graduates, 1980-1988. *J Am Vet Med Assoc* 1989;194:283–284.

A5100-7
v194/54

June 15, 1989, Volume 194, Number 12

JOURNAL

OF THE AMERICAN VETERINARY MEDICAL ASSOCIATION

800185262 1 061589 2 23 J
CONGRESSIONAL INFO SERV **
MR ED KIANKA STAT REF INDEX **
4520 EAST WEST HWY **
BETHESDA MD 20814 **

3

Research Roundup

Transmission is unsolved mystery of equine monocytic ehrlichiosis 1681

Pages from the Past

American Indians and their horses' health 1690

New Feature

Food for thought for food animal veterinarians 1698

Special Report

Drug residues in food animals 1700

Veterinary Medicine Today

Iohexol and iopamidol: New contrast media for veterinary myelography 1714

Economic Note

1987 Gross practice income attributable to veterinary service and product categories 1767

JOURNAL
OF THE AMERICAN VETERINARY MEDICAL ASSOCIATION

© American Veterinary Medical Association, 1989
All Rights Reserved

Vol 194 June 15, 1989 No. 12
JAVMA 194 (12) 1673-1852 (1989)
ISSN 0003-1483

Interpretive Summaries of Articles in This Issue 1676

Letters

Taurine and other dietary considerations for cats 1679
The siren song of merchandising 1680

News

Research Roundup—Transmission is unsolved mystery of equine monocytic ehrlichiosis . . 1681
AVMA at Work—Revised *Principles* awaits House action 1686
Committee accredits three new programs . 1686
Fireside Chat—President reviews state of AVMA 1688
Pages from the Past—American Indians and their horses' health 1690
Coast to Coast—Dental prophylaxis issue addressed by Board of Examiners 1692
Insurance Information—Benefits of the AVMA Professional Liability Insurance Trust 1693
Edge of Education 1694
Deaths 1696

Food for thought for food animal veterinarians

Where did the art of practice go?—*John B. Herrick* 1698

Special Report

Drug residues in food animals—*W. R. Van Dresser and J. R. Wilcke* 1700

The *Human* Side of Veterinary Medicine

A coming unity crisis in veterinary medicine?—*Jacob Antelyes* 1712

Veterinary Medicine Today

Iohexol and iopamidol: New contrast media for veterinary myelography—*William R. Widmer* 1714

Reports of Original Studies

Comparison of four screening techniques for the diagnosis of equine neonatal hypogammaglobulinemia—*Debra L. Clabough, H. Steve Conboy, and Malcolm C. Roberts* 1717
Treatment of canker in horses—*David G. Wilson, Maron B. Calderwood Mays, and Patrick T. Colahan* 1721

Clinical Reports

Blue-green algae (*Anabaena spiroides*) toxicosis in pigs—*M. M. Chengappa, Lanny W. Pace, and Bruce G. McLaughlin* 1724
Cecal volvulus in a ewe—*P. D. Modransky, F. H. Welker, W. K. Scarratt, and A. M. Rashmir* 1726
Primary ovarian adenocarcinoma associated with teratomatous elements in a mare—*Steven D. Van Camp, Joel Mahler, Malcolm C. Roberts, Lloyd P. Tate, and Michael D. Whitacre* 1728
Treatment of a comminuted middle phalangeal fracture in a horse by use of a broad dynamic compression plate—*C. F. Bukowiecki and L. R. Bramlage* 1731
Laryngeal paralysis in immature and mature dogs as one sign of a more diffuse polyneuropathy—*Kyle G. Braund, H. Steven Steinberg, Andy Shores, Janet E. Steiss, Jagjivan R. Mehta, Maria Toivio-Kinnucan, and Karen A. Amling* 1735
Congenital cranioventral abdominal wall, caudal sternal, diaphragmatic, pericardial, and intracardiac defects in Cocker Spaniel littermates—*Jamie R. Bellah, Crispin P. Spencer, Donald J. Brown, and Doris L. Whitton* 1741
Female pseudohermaphroditism in three sibling Greyhounds—*P. N. Olson, H. B. Seim, R. D. Park, J. L. Grandy, J. L. Freshman, and E. D. Carlson* 1747

Reports of Retrospective Studies

Internal fixation of femoral capital physeal injuries in dogs: 40 cases (1979-1987)—*Charles E. DeCamp, Curtis W. Probst, and Michael W. Thomas* 1750

Use of dynamic compression plates for treatment of tibial diaphyseal fractures in foals: Nine cases (1980-1987)—*David R. Young, Dean W. Richardson, David M. Nunamaker, Michael W. Ross, and Eric P. Tulleners* 1755

Guttural pouch tympany: 15 cases (1977-1986)—*Patrick M. McCue, David E. Freeman, and William J. Donawick* 1761

Silicone ocular prosthesis in horses: 11 cases (1983-1987)—*P. J. Provost, A. I. Ortenburger, and J. P. Caron* 1764

Economic Note

1987 Gross practice income attributable to veterinary service and product categories—*J. Karl Wise* 1767

What Is Your Diagnosis?

Clifford M. Honnas, Tina Kemper, and Robert L. Linford 1769

Abstracts of AVMA Convention Reports 1771

Book Reviews

Handbook of Veterinary Anesthesia 1723
Infectious Diseases of Cats 1725
The Clinical Chemistry of Laboratory Animals 1727
Infectious Diseases of Dogs 1730
Fertility and Obstetrics in the Horse 1749

Announcements

Coming Meetings 1821
Foreign Meetings 1824
Applications for Membership 1825
Certification Examinations 1829
State Board Examinations 1829
Educational Opportunities 1830

Classified Ads 1834

Coming Soon . . .

July 1 issue

Forum—Animal rights: A biological contradiction (F. S. Jacobs)

Legal Brief—Dissolution of a veterinarian's marriage (H. W. Hannah)

Reflections—Factors influencing the evolution of theriogenology (D. E. Bartlett)

4-Methylpyrazole as treatment for ethylene glycol intoxication in dogs (S. M. Dial et al)

Presidential Preview—Interview with Dr. Samuel Strahm

July 15 issue

New Feature—Food for thought for food animal veterinarians—One bad apple affects a barrel of apples (J. B. Herrick)

Forum—National Board Examination revisited (R. L. West)

Council Report—AVMA guidelines for dealing with AIDS-infected persons in the veterinary workplace (A. V. Tennyson)

The *Human* Side of Veterinary Medicine—The previous veterinarian (J. Antelyles)

Special Report

Drug residues in food animals

W. R. Van Dresser, DVM, and J. R. Wilcke, DVM, MS

Preface

With the following report, we intend to provide an accurate image of the current situation regarding animal drug residues in food animals. We include assessments of cause, amount of involvement for various production classes, profiles of the therapeutic regimens for the drugs involved, indications of labeling and veterinary instruction, relationships to regulatory descriptions, and the relative frequency of responsibility assigned to the various segments of the food animal industry (eg, producer, veterinarian, auction barns).

This report is derived from 2 kinds of information. First, we have made an independent compilation of field investigations conducted by FDA/CVM and the Office of the State Veterinarian, VDACS. The field investigations were based on residues detected through one of the USDA/FSIS residue-testing programs on food animals in normal marketing channels. Investigations were conducted by FDA/CVM on the basis of information provided by USDA. Second, this report is a broad review of the available literature on the subject of drug residues. Most of this literature comes from studies conducted by regulatory agencies with authority for drug residues (USDA/FSIS, CVM/FDA, and State Departments of Agriculture).

One precaution must be made before this report is used as a reference for decision making. Specific cases for field investigation were selected, by means unknown to us, by individuals who were not involved in our study. We do not assert that the data were gathered in a random and unbiased fashion. The data were not gathered for the purpose of our analysis. We are also aware that bias is difficult to avoid in an investigation of this type. The use to which data will be put (eg, regulatory, marketing, demographic) may affect its relationship to the population as a whole. If the USDA/FSIS identifies a problem market class, FDA/CVM reasonably draws a sample from the population that emphasizes this market class during certain periods, for certain geographic locations, or for certain slaughter plants. We do believe that the information contained herein is, in fact, representative of the residue situation as it exists in the "real world," and believe that comparison of independent surveys would support this conclusion.

We make no attempt to lend the weight of statistical analysis to our discussions. We have proposed hypotheses, rather than stated conclusions, because of the necessary limits imposed by the source(s) and magnitude of the data. These limits are acknowledged in the report where appropriate.

It would be a disservice to those who undertake to solve the problems associated with drug residues in food animals if the report were taken out of context or if the findings were interpreted in a manner that went beyond the restrictive boundaries of logic and reason. This strong precaution is not to convince the reader that the report will not be useful in giving insights or confirming empirically derived conclusions as to the nature, extent, and causes of drug residues in food animals. Rather, the report cannot be applied to the whole universe of drug residues. This is not a scientific investigation of drug residues in food animals. It is an accounting of a situation within a dynamic industry that, for much of the information this study provides, has been sampled in a limited way.—
W. R. Van Dresser and J. R. Wilcke

Summary: *A total of 292 field investigative reports of drug residues in food animals for 1983 to 1988 were analyzed. The investigations had been conducted by the Food and Drug Administration (FDA) and the Virginia State Veterinarian's Office, in cooperation with the Center for Veterinary Medicine of the FDA, to trace residues reported by the USDA Food Safety and Inspection Service to the source of the animal and the administration of the drug.*

The analysis disclosed the following. (1) Antibiotic residues were most often associated with streptomycin, penicillin, oxytetracycline, and neomycin. Sulfamethazine was, by far, the most frequently cited sulfonamide. (2) Residues are being found predominantly in cows, veal calves, and market hogs (barrows and gilts). (3) The cause of drug residue most frequently cited by the field investigators was failure to observe the withholding time for the drug. Almost half of these investigations revealed that the individual responsible for the sale of the animal did not know the proper withholding time for the drug. Failure to maintain adequate records was also a contributing factor. (4) The producer was considered to be the responsible party in over 80% of the cases for which responsibility was determined. (5) Residues associated with injectable drugs were investigated most frequently. Long-acting and sustained-release products were most often associated with penicillin and oxytetracycline residues. (6) The 2 most common sources of purchase for the drugs involved in the investigations were the feed/farm supply store and the veterinarian. (7) Unapproved drug use was not a major cause of residues.

Residues of therapeutic and production-enhancing drugs in food products derived from domestic animals are a topic of considerable concern in all dimensions of the food animal industry. Producers and the national organizations that represent them are confronted by consumers who are increasingly aware of the health consequences of the food they eat. This "food consciousness" includes a greater awareness of the production practices that expose food animals to drugs. Negative, inflammatory, and misleading advertising sponsored by the Humane Farming Association has been used to condemn animal husbandry practices in the veal industry.[1] A portion of this advertising has been directed at the use of antimicrobials in the veal industry. The sponsors of the advertisement suggest that "antibiotic-laced" formulas induce severe diarrhea, "create virulent strains of bacteria that wreak havoc on human health," and leave residues that are directly toxic to human beings.

A strong negative association between antibiotic use and food wholesomeness, accurate or not, reflects on the larger food animal industry. In response, producers are increasing their awareness of the potential regulatory and marketing problems associated with drug residues. At the present time, it is unlikely that one could pick up a journal dedicated to animal production without finding a scientific discussion, editorial, or advertisement that speaks to the problem. The producer is seeking information that can be used to maintain the wholesomeness and marketability of food animal products.

Veterinarians, too, are facing a dramatic change in attitude and behavior concerning drug residues and, in broader context, their therapeutic use of drugs. For too long, veterinarians have paid insufficient attention to the instructions of the producer in the appropriate use of drug products and to the labels placed on drugs. Suddenly, and with increasing frequency, veterinarians are faced with an educated producer who wants assurances that drugs administered will not result in residues at the time of sale. The veterinarian needs information to address this problem in a correct and useful way. Abilities in diagnostic medicine and therapeutics, demographic and scientific research, residue testing and consultation for producers, and client education place veterinarians in a strategic position to influence drug residue incidence in food animals.

Finally, it is clear that the pharmaceutical industry will participate in the changes in the food animal industry as a result of these marketplace events. The current system of drug distribution through both over-the-counter and professional channels may face some revision. In certain cases, specific generic or brand-name items have become associated with the production of excessive numbers of violative residues. It seems likely that this association will be as detrimental to a drug's market share or regulatory safety as would a high incidence of some physical side effect in the treated animal. The association will be built on believable information concerning specific products or practices that lead directly to residues.

Materials and methods

Previously unpublished information included in this report was obtained by the authors from the

---

From the Departments of Large Animal Clinical Services (Van Dresser) and Veterinary Biosciences (Wilcke), Virginia-Maryland Regional College of Veterinary Medicine, Veterinary Medicine Experiment Station, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061. Dr. Van Dresser's present address is AVMA Governmental Relations Division, 1023 Fifteenth St, NW, Suite 300, Washington, DC 20005-2602.

This study was funded by the AVMA.

This report would not have been possible without the full cooperation of a number of government agencies and individuals. We wish to cite the USDA Food Safety and Inspection Service (USDA/FSIS), The Food and Drug Administration's Center for Veterinary Medicine (FDA/CVM), The Virginia Department of Agriculture and Consumer Services (VDACS), Division of Animal Health, Office of the State Veterinarian, Division of Dairy and Foods; and the USDA Extension Service. The following individuals within these agencies were especially helpful: Dr. Lester Crawford, Dr. W. R. Miller, and Dr. John Honstead from the USDA/FSIS; Dr. Gerald Guest, Dr. Richard Teske, Dr. Joseph Paige, and Dr. Richard Talbot from FDA/CVM; Dr. W. D. Miller, Dr. P. J. Friedman, and Mr. Archie C. Holliday from VDACS.

Center for Veterinary Medicine of the Food and Drug Administration (FDA/CVM) and from the Virginia Department of Agriculture and Consumer Services (VDACS) in cooperation with FDA/CVM. In both cases, investigations were conducted after the detection of a residue through the USDA/FSIS residue monitoring or surveillance programs. The FDA/CVM reports were filed by FDA field personnel from 17 district offices, and were collected by the CVM. The VDACS reports were filed by veterinarians from the Office of the State Veterinarian in Virginia. Archived reports were in narrative form and described the investigator's visit to the production unit.

Summary questionnaires were prepared, and the narrative reports were extracted. All reports filed during calendar years 1986 to 1987 (FDA/CVM) or 1983 to 1988 (VDACS) that were available to us at the time of extraction were included. Extractions were completed by one of the authors or by an individual under subcontract to the authors. Questionnaires were recorded by use of a personal computer and a commercial database program.

Extractions and tabulation of the records were accomplished by use of the same computer and a commercial spread-sheet program that reads the database file directly. Statistical methods were not used in analysis of the data. Results are expressed either as the absolute number of records or residues, or as a percentage of all records or residues. The difference between records and residues comes from the finding of multiple residues in some animals in both studies. Some characteristics seemed to be more directly linked to the individual residue, rather than to the "case" as a whole. For example, when we described the relationship between a generic name and the residue detected, it seemed more appropriate to express results as a percentage of all residues (rather than a percentage of records).

Results

OVERVIEW OF FDA/CVM AND VDACS FIELD INVESTIGATIONS

Drug and drug product—Incidence of residues by drug was the most accessible and complete information in the 2 studies. This is simply because the residue, as determined by USDA/FSIS, initiates each investigation. The drug residue information is rarely (3.7% in the combined studies) unavailable. Drugs most commonly involved in residues included streptomycin (20.2% and 19.2%), penicillin (13.1% and 13.1%), sulfamethazine (10.3% and 15.2%), and oxytetracycline (9.1% and 7.1%) in FDA/CVM and VDACS reports, respectively. Table 1 gives the incidence of all residues investigated by FDA/CVM investigators and by veterinarians of the VDACS. Investigations that did not report a specific residue, such as unidentified microbial inhibitor or calf antibiotic and sulfonamide test, are also included.

Table 1—Incidence of particular drug residues in the tissue residue field investigation database

Residue	FDA/CVM		VDACS	
	No.	(%)	No.	(%)
None	11	(4.4)	2	(2.0)
Antibiotics	16	(6.3)		
Penicillin	33	(13.1)	13	(13.1)
Streptomycin	51	(20.2)	19	(19.2)
Tetracycline	8	(3.2)	2	(2.0)
Tylosin	2	(0.8)		
Erythromycin	2	(0.8)	1	(1.0)
Neomycin	22	(8.7)	4	(4.0)
Oxytetracycline	23	(9.1)	7	(7.1)
Chlortetracycline	3	(1.2)	3	(3.0)
UMI	22	(8.7)	10	(10.1)
Gentamicin sulfate	13	(5.2)	5	(5.1)
Zearalanol	1	(0.4)		
Zearalenone	2	(0.8)		
Sulfonamides	9	(3.6)		
Sulfadimethoxine	4	(1.6)		
Sulfamethazine	26	(10.3)	15	(15.2)
Sulfamerazine	1	(0.4)		
Sulfathiazole	1	(0.4)	1	(1.0)
Sulfamethiazole			1	(1.0)
Halofuginone	2	(0.8)		
CAST			16	(16.2)
Total	252		99	

UMI = Unidentified microbial inhibitor, CAST = calf antibiotic and sulfonamide test

Trade names were also recorded in a limited number of reports within the FDA/CVM database. Ninety-two of 252 (FDA/CVM) and 69 of 100 (VDACS) residues were associated with enough information to determine either the generic or trade name of the drug product administered. Table 2 lists the generic names associated with residues for the 4 most common residues found in the 2 surveys. Penicillin residues were associated with sustained-release penicillin products, either alone or in combination with other drugs. Of 16 streptomycin residues, 14 were associated with the same combination products that led to penicillin residues. For neomycin, 5 of the 6 documented resi-

Table 2—Drug products associated with certain antibiotic residues in field investigations (totals are for both FDA/CVM and VDACS studies and indicate all residues for which this information was known)

Residue investigated	FDA/CVM	VDACS
Penicillin		
Procaine penicillin G (PPG)	5	1
PPG + dihydrostreptomycin (DHSM)	4	10
PPG + DHSM chlorpheniramine (CPHM) + dexamethasone (DXM)	3	1
Benzathine penicillin G (BPG)	2	0
More than one source of penicillin G	1	0
Total	15	12
Streptomycin		
PPG × DHSM	10	4
PPG × DHSM × CPHM × DXM	4	0
PPG × DHSM intrammamary suspension	2	0
Total	16	4
Neomycin		
Neomycin sulfamethazine*	2	0
Neomycin sulfate†	4	0
Total	6	0
Oxytetracycline		
Oxytetracyline (long-acting injection)	4	2
Oxytetracycline (injectable)‡	5	3
Total	9	5

*Also associated with sulfamethazine residue. †One oral dose with one IV dose. ‡One report also included with sulfamethazine residue.

dues were associated with oral administration of neomycin. For oxytetracycline, 4 of 9 residues were also associated with a sustained-release product.

Multiple residues—A total of 206 FDA/CVM and 86 VDACS field investigations were analyzed. Multiple residues were found in 18% (FDA/CVM) and 18.6% (VDACS) of the records in the database.

Drug distribution and use: Operations, sources, labeling—A profile of the FDA/CVM study, relative to the type of operation investigated, is shown in Table 3. The study emphasizes the private dairy farm (33.5%), the private on-farm producer of swine, veal, beef, and poultry (32.5%), and buyers and dealers of food animals (15.7%). The other category was almost exclusively slaughter facilities, and these reports generated almost no other data (eg, drug product, route). Operations investigated by either FDA or VDACS field inspectors obtained drug products from several sources (Table 4). In the FDA/CVM reports, the feed and farm supply store (38.9%) and the veterinarian (40.3%) were nearly equal as the dominant sources for the drugs. In the VDACS study, most products were obtained from the same 2 sources, but veterinarians sold fewer of the drugs (20.9%) than did the feed and farm supply store (74.4%).

The label on a drug product is the primary method for distributing therapeutic (eg, dose, indications) and regulatory (eg, dating, purity, ingredients) information, and it is the specific instrument of regulatory enforcement by the FDA. In most cases, the drug product was unavailable for inspection. This was usually a reflection of the time from the detection of a residue until the farm inspection was conducted. At times, the investigation ended at the slaughter plant, and no other information was sought by the field investigator. When the drug was available, an overwhelming majority of the drug products involved were labeled appropriately. Labeling was on 87.2% (FDA/CVM) and 80.6% (VDACS) of the drug products implicated in all reports when the information was available (86 for FDA/CVM and 36 for VDACS).

Only the VDACS study included a distinction between over-the-counter (OTC) and restricted (Rx) drugs, made by the investigators in the field. Although we had some trade name information in the FDA/CVM study, this status can change for a given trade name product, and we believed that it was inappropriate to make assumptions as to regulatory status. In the VDACS reports, we found that 81.8% of the drug products involved were OTC and 18.2% were Rx. This latter percentage parallels the percentage of drugs sold through so-called professional channels, as described in the same VDACS reports. We would hasten to point out that veterinarians were sources for OTC drugs in a number of FDA/CVM reports, so this association is by no means complete.

Table 3—Incidence, by type of operation, in tissue residue field investigation database (FDA/CVM database)

Operation type	No.	(%)
Feedlot	9	(4.6)
Poultry flock	0	(0.0)
Dairy farm	66	(33.5)
On-farm producer*	64	(32.5)
Sales barn	3	(1.5)
Buyer/dealer	31	(15.7)
Animal hauler	6	(3.0)
Other	18	(9.1)
Total	197	

Type of operation was unknown in 13 instances.
*Includes beef, swine, poultry, veal.

*Table 4—Incidence in tissue residue field investigation database, by known drug source**

Drug source	FDA/CVM		VDACS	
	No.	(%)	No.	(%)
Veterinarian	29	(40.3)	9	(20.9)
Supply house	3	(4.2)	1	(2.3)
Feed and farm/supply store	28	(38.9)	32	(74.4)
Mobile peddler/truck	6	(8.3)	0	(0.0)
Other	6	(8.3)	1	(2.3)
Total	72		43	

*Drug source was unknown in 138 (FDA/CVM) and 43 (VDACS) instances.

Market class—A complete accounting of market class association with drug residue field investigations is given in Table 5. Residues found in cows (95, FDA/CVM; and 40, VDACS) were investigated most frequently. The incidence in other adult cattle was substantially lower. Residues in veal calves were investigated with the second highest frequency (47 and 13), and barrows and gilts were third most frequently investigated (27 and 5).

Table 5—Incidence of individual market classes in tissue residue field investigation database

Market class	FDA/CVM		VDACS	
	No.	(%)	No.	(%)
None given	7	(3.4)	1	(1.2)
Bulls	0		1	(1.2)
Steers	6	(2.9)	2	(2.4)
Cows	95	(46.1)	40	(47.6)
Heifers	1	(0.5)	0	
Calves (unidentified)	2	(1.0)	8	(9.5)
Bob veal	47	(22.8)	13	(15.5)
Formula-fed veal	3	(1.5)	2	(2.4)
Non-formula-fed veal	6	(2.9)	11	(13.1)
Barrows and gilts	27	(13.1)	5	(6.0)
Sows	9	(4.4)	1	(1.2)
Turkeys	1	(0.5)	0	
Chickens	2	(1.0)	0	
Total	206		84	

Pharmacologic information: Dose form, route of administration—The potential association between the route of administration and the presence of drug residues was evaluated. Results of this study indicate that injectable drugs are more likely to cause residues. Injectable drugs were associated with 51.3% (FDA/CVM) and 60% (VDACS) of the residue reports. Feed additives were the second most prevalent form in the FDA/CVM reports

(21.4%). Boluses were second most frequent for the VDACS reports (30%). Information on dose forms and routes of administration is given in Tables 6 and 7.

Although numbers are small, other routes of administration pose interesting problems. A number of neomycin residues were associated with the oral administration of neomycin sulfate. This is not consistent with the generally held belief that orally administered aminoglycosides are not absorbed, and suggests the need for further study. In one report, dairy calves fed cow's milk withheld from market because of antimicrobial administration to the cow developed residues. Such use of "mastitic milk" is not, we believe, uncommon.

Identifiable cause—Identifiable causes are those deduced as contributing to drug residues. In many records, more than one cause was linked to the eventual residue. Often, insufficient information was available to suggest a cause for the residues (106 records for the FDA/CVM study and 30 for the VDACS study). A complete account of causes appears in Table 8.

For those records wherein identifiable cause could be determined and traced back to the administration of the drug, failure to observe withdrawal times was the leading cause of illegal residues. In the FDA/CVM data, 36.9% of all records and 69.1% of those wherein the field investigator determined a cause were associated with failure to observe withdrawal time. In the VDACS data, 58.1% of all records and 89.3% of those wherein cause was determined were similarly associated with observation.

Table 6—Incidence of known dose form in tissue residue field investigation database*

Dose form	FDA/CVM		VDACS	
	No.	(%)	No.	(%)
Injectable	60	(51.3)	36	(60.0)
Bolus	18	(15.4)	18	(30.0)
Feed additive	25	(21.4)	3	(5.0)
Water additive	8	(6.8)	2	(3.3)
Intramammary infusion	3	(2.6)	1	(1.7)
Other	3	(2.6)	0	(0.0)
Total	117		60	

*Dose form was unknown in 103 (FDA/CVM) and 26 (VDACS) instances.

Table 7—Incidence of known routes of administration in tissue residue field investigation database*

Route of administration	FDA/CVM		VDACS	
	No.	(%)	No.	(%)
Injection	60	(51.3)	37	(61.7)
Bolus	18	(15.4)	16	(26.7)
Feed	25	(21.4)	4	(6.7)
Intramammary	5	(4.3)	2	(3.3)
Water	5	(4.3)	1	(1.7)
Other	4	(3.4)	0	(0.0)
Total	117		60	

*Route of administration was unknown in 103 (FDA/CVM) and 27 (VDACS) instances.

Table 8—Incidence of primary causes of drug residues as described in tissue residue field investigation database

Primary cause	FDA/CVM	VDACS
Withdrawal time not followed and not known	38	41
Withdrawal time not followed and known	38	9
Label not followed	36	22
Veterinarian's direction not followed	7	
Exceeded dose	2	
Unapproved use	8	2
Poor production practices	16	11
Improper mix of feed	6	7
Fed milk containing drug	2	
Given by mistake	2	1
Wrong feed	3	2
Could not determine	106	30

Failure to maintain records was also associated with illegal residues in 7.7% (FDA/CVM) and 12.8% (VDACS) of the records. Other identifiable causes of illegal drug residues determined in the FDA/CVM and VDACS studies, making up ≤5% of the total, included "exceeded recommended dose, improper mix of feed, fed milk containing a drug residue to calves, and mistaken administration."

The unapproved use of a drug is listed as a cause of violative residues in the residue follow-up report form and is included as a cause in 7.2% (FDA/CVM) and 3.6% (VDACS) of the total reports in each analysis. Unapproved drug use is given as a sole cause in only 1 (FDA/CVM) of the reports. Reports did not distinguish between veterinarians and other drug administrators in this regard.

Responsibility—The individuals who administered the drug product to the animal(s) involved in the residue report are identified in Table 9. Accounting only for those reports wherein this individual was known, the drug involved in the residue was given by the animal owner or someone responsible to the owner in 94% (FDA/CVM) and 98% (VDACS) of the time. Although responsibility was assigned by the investigator in the field, it seems reasonable to conclude that the individual who administers the drug is most often held accountable. This is supported by the assignment of responsibility, as displayed in Table 10. When known, responsibility was assigned to the producer (owner) at rates of 80.8% (FDA/CVM) and 92.5% (VDACS).

Table 9—Incidence of known drug administrator in tissue residue field investigation database*

Who treated?	FDA/CVM		VDACS	
	No.	(%)	No.	(%)
Owner	75	(70.8)	45	(86.5)
Family member	3	(2.8)	2	(3.8)
Hired hand	16	(15.1)	4	(7.7)
Veterinarian	9	(8.5)	0	(0.0)
Animal hauler	0	(0.0)	0	(0.0)
Auction barn employee	0	(0.0)	0	(0.0)
Buyer/dealer	0	(0.0)	0	(0.0)
Other	3	(2.8)	1	(1.9)
Total	106		52	

*Drug administrator was unknown in 101 (FDA/CVM) and 33 (VDACS) instances.

Table 10—Incidence of known responsibility in the tissue residue field investigation database*

Who was responsible?	FDA/CVM		VDACS	
	No	(%)	No	(%)
Producer	84	(80.8)	49	(92.5)
Veterinarian	7	(6.7)	0	(0.0)
Feed mill	1	(1.0)	0	(0.0)
Buyer/dealer	4	(3.8)	2	(3.8)
Mixer/feeder	4	(3.8)	0	(0.0)
Auction barn	0	(0.0)	0	(0.0)
Animal hauler	1	(1.0)	2	(3.8)
Other	3	(2.9)	0	(0.0)
Total	104		53	

*Responsibility was unknown in 104 (FDA/CVM) and 49 (VDACS) instances.

VETERINARY INVOLVEMENT IN FDA/CVM-SPONSORED INVESTIGATIONS

The sale of the drug product represents the point of contact for the transmission of appropriate information concerning drug use and drug withdrawal times. For this reason and because the question of involvement of a local veterinarian was not elicited directly, we chose to select a subset of records from our original database for which we had a clearly identified source. From the original FDA/CVM data, this included 44 records wherein the source of the drug was a veterinarian and 59 records wherein the source of the drug was a feed store, a cooperative, or some other lay distribution source. The VDACS included only 9 records wherein the veterinarian was the source of the drug, so these data were not analyzed further. Results that follow are taken from the FDA/CVM records only.

Drug and drug product—Drugs investigated in largest numbers included penicillin, streptomycin, neomycin, oxytetracycline, and sulfamethazine. The frequencies of inclusion were roughly similar for either veterinary or lay-source drugs, the major difference being sulfamethazine (Table 11). The generic names of the drugs were similar for either source of drugs. Penicillin residues were nearly always associated with procaine penicillin G administration and streptomycin with some combination of procaine penicillin G and dihydrostreptomycin. Veterinarians were likely to have administered or dispensed a combination of procaine penicillin G, dihydrostreptomycin, and a glucocorticoid. With neomycin, veterinary involvement meant boluses (2 of 3 cases) or injection (1 case), whereas lay distributors favored liquids for oral administration (4 of 5 cases). Sulfamethazine (in this study) was usually given in feed, and feed-additive sulfamethazine was sold by a veterinarian in only one case.

Table 11—Source of generic drugs associated with residues, expressed as an absolute count and as a percentage of the residues from the particular source

Generic drug	Source			
	Veterinarian		OTC	
	No.	(%)	No.	(%)
Antibiotics	2	(4.5)	2	(4.2)
Penicillin	11	(25.0)	6	(12.5)
Streptomycin	10	(22.7)	8	(16.7)
Tetracycline	2	(4.5)	1	(2.1)
Tylosin	0	(0.0)	1	(2.1)
Neomycin	3	(6.8)	5	(10.4)
Oxytetracycline	4	(9.1)	6	(12.5)
Chlortetracycline	1	(2.2)	0	(0.0)
UMI	3	(6.8)	2	(4.2)
Gentamicin	2	(4.5)	1	(2.1)
Zearalenone	0	(0.0)	2	(4.2)
Sulfonamides	1	(0.0)	2	(4.2)
Sulfadimethoxine	1	(2.2)	0	(0.0)
Sulfamethazine	2	(5.4)	9	(19.8)
Sulfamerazine	1	(2.2)	0	(0.0)

UMI = Unidentified microbial inhibitors

Drug distribution and use: Operations, sources, labeling—In types of operations involved in residue investigations, feedlots (cattle) composed 11.4% of the operations that involved a veterinarian. All reports that involved feedlots (cattle) indicated that the veterinarian was the source of drugs administered. Other classes of operation included dairy farms, on-farm producers, buyers and dealers, and animal haulers. Veterinarians and lay channels shared equally as sources of drugs for these operations.

When drug products were available for inspection, they bore descriptive labeling in 82.9% (veterinary source) and 95% (lay source) of reports that were identified in the source-identified subset of reports. The label was considered by the field investigator to be appropriate for 76.7% (veterinary source) and 89.5% (lay source) of the drug products identified. The written or verbal orders of a veterinarian usually were considered unnecessary by the field investigator when the drug was purchased through lay channels, although written and verbal orders were documented in a limited number of such reports. When a veterinarian was identified as the source of the drug, written orders were given 47.7% of the time and verbal orders were given 67.7% of the time. In 13.6% of these reports, both verbal and written orders were given.

Market class—As stated previously, cows, veal calves, and barrows and gilts were the market classes most often associated with drug residues in both the FDA/CVM and VDACS reports. For FDA/CVM data, when source was known, a veterinarian was most likely to be involved, either as the source of the drug or as its administrator, in violative residues of cows (55.8%). Bob veal (14%), calves of unspecified type (9.3%), and steers (6.9%) were the next most likely. Lay distribution channels were still important sources of violative residues in cows (36.7%), bob veal (30.6%), and barrows and gilts (16.3%).

Identifiable cause—Proportions of various identifiable causes of drug residues were roughly the same, regardless of drug source. Exceptions included lack of knowledge of withdrawal time (less frequent for lay-source drugs), exceeded dose (only listed when veterinarian was the source), and unapproved use (only listed for lay-source drugs).

Responsibility—Whether the drug was obtained from a veterinarian or another distributor, overwhelming responsibility was assigned to the producer. When there was no veterinary involvement, 81.3% of the residues were the responsibility of the producer. When veterinarians sold the drug product, 63% of the records still indicated that the producer was responsible. Veterinarians did bear sole responsibility 12.5% of the time, and shared it with the producer an additional 8.3% of the time. In no case was a veterinarian considered to be responsible when the drug was purchased from someone else.

Discussion

DRUG AND DRUG PRODUCT

Before discussing causes and responsibility, as suggested by the field investigations, it is important to consider the accuracy with which they represent the whole population of food animals. Our estimate for the population incidence of specific drug residues is taken from the USDA/FSIS Domestic Residue Databooks for the years 1983 to 1986.[2-5] For this purpose, we include only data derived from the USDA/FSIS Monitoring Program. The monitoring program "is designed to provide profile information on the occurrence of residue violations in specified animal populations on an annual national basis. The focus of the program is on violations; therefore, only compounds with tolerances or action levels are included in the monitoring plan. Monitoring information is obtained through a statistically based selection of random samples from animals under inspections that appear healthy."[6] Trend analyses and population estimates have been published by FSIS personnel.[7] To date, our review of published USDA monitoring and surveillance data concurs with this report, which emphasizes a limited lumber of problem market classes. For our purposes, we sought to compare the incidence of generic names and market classes relative to each other, rather than to estimate total incidence within a population. We chose to treat the 4 years of monitoring data as one set and to report a single incidence for segments of the food animal industry of interest to us. Although the USDA/FSIS Monitoring Program is conducted so that statistical analysis can be completed, it is not our intent to represent that this information is a statistical summary of population incidence. We simply use it as an independent assessment of the same population that we studied and appreciate that it is broader in scope.

The incidence of individual antibiotic and sulfonamide residues detected by the USDA from 1983 to 1986, along with similar figures from the FDA/CVM and VDACS studies, are listed in Table 12. In order to give perspective to our study of FDA/CVM-sponsored investigations, antibiotic and sulfonamide rates were compared separately. This separation was necessary because the antibiotic and sulfonamide data from the USDA publications were gathered in independent monitoring programs. The FDA/CVM and VDACS data include a larger proportion of penicillin residues than do the USDA data. Likely, this reflects the emphasis on injectables and cows as a market class that we described earlier. Sulfamethazine is underrepresented in FDA/CVM reports, probably for the same reason. The USDA/FSIS data probably are representative of the true population; we believe our compilation is a reasonably accurate reflection of the incidence for specific residues and the factors discussed here.

Table 12—Frequency of antimicrobial residues determined for FDA/CVM and VDACS field investigations and for the USDA Monitoring program for 1983 to 1986 (results expressed as percentage of antibiotic or sulfonamide residues observed)

Residue	FDA/CVM (%)	VDACS (%)	USDA (%)
Antibiotics			
Penicillin	16.9	20.3	9.4
Streptomycin	26.1	29.7	40.6
Tetracycline	4.1	3.1	6.3
Erythromycin	1.0	1.6	0.8
Neomycin	11.3	6.3	33.5
Oxytetracycline	11.8	10.9	4.7
Chlortetracycline	1.5	4.7	2.3
UMI*	11.3	15.6	22.7
Gentamicin	6.7	7.8	0.8
Sulfonamides			
Sulfamethazine	63.4	88.2	89.8
Sulfathiazole	2.4	5.8	6.2
Sulfadimethoxine	9.7	0.0	3.5

UMI-Unidentified microbial inhibitors.

DRUG DISTRIBUTION AND USE

Hypothesis: Drug residues are a function of the sales volume of the drug, confounded by pharmacologic factors including slow absorption from injection sites, extremely prolonged elimination, and recycling of the drug from bedding and waste.

Likely, the incidence of a given drug or drug product in this study is influenced by its share of the market. The source of information we used to assess market share is the Michigan National Animal Health Monitoring System (NAHMS) report for 1987.[8] By extracting data from a survey of drug use in cattle of all ages and a variety of diseases (including gastrointestinal problems, respiratory problems, lameness, metabolic or nutritional, multiple systemic, and diseases of organs of special sense) we determined that penicillin (51.5%), streptomycin (15.1%), tetracyclines (13.8%), sulfonamides, (14.2%) and neomycin (5.3%) were the most commonly used antimicrobials in cattle. In calves, ranking was different, but included sulfonamides (31.7%), penicillin G (31.3%), tetracyclines (16.3%), gentamicin (8.3%), streptomycin (8.3%), and spectinomycin (4%). Additionally, a survey of dairy farms conducted by the Consumer

Protection Division of the Colorado Department of Health found the following drugs to be most common: penicillin G (70% of 70 dairy farms surveyed), sulfonamides (70%), oxytetracycline (68%), cephapirin (49%), and tylosin (38%).[9] It seemed a reasonable assertion that the presence of a drug on the farm was an indication of its use.

The incidence of residue violations investigated in the FDA/CVM and VDACS studies is presented in Table 1. Streptomycin, penicillin G, sulfonamides, tetracyclines, and neomycin were the most frequently reported violations in the FDA/CVM and VDACS reports.

We expect that the frequency of violations would also parallel total sales for both lay and "ethical" distribution channels (few of these were Rx) if such information were readily available. However, there is also an association between incidence and the availability of long-acting or sustained-release products. Furthermore, both streptomycin and neomycin have unusually long elimination half-lives from kidney tissue, which contributes to the potential for residues. The contribution of pharmacokinetic behavior of the specific drugs involved remains to be evaluated critically.

A complete review of pharmacokinetic causes of drug residues is beyond the scope and intent of this report. However, a brief listing of some of these associations is in order. It is known, for example, that sulfamethazine residues may be caused by failure to clean feeding equipment (and that sulfamethazine presents a greater hazard compared with other feed additives), and recycling from a contaminated environment.[10]

Residues of aminoglycosides are known to bind covalently to tissues in the kidney and to persist for extended periods after exposure to low concentrations.[10] This could account for the increased relative incidence of streptomycin as a residue in our analyses, compared with the relative prevalence of the product in the drug-use surveys previously mentioned. Also, conventional pharmacologic wisdom suggests that these products are not absorbed after oral administration. In our study, however, 5 of 6 documented neomycin residues were associated with oral administration of the drug. This finding deserves attention in terms of frequency and relationships between residues and specific diseases, management practices, or animal age. The long elimination time for aminoglycosides may be the reason this unexpected absorption has been detected.

Procaine and benzathine penicillin G accounted for all of the penicillin residues for which trade name of the drug product was known. Each of these dose forms is preferred because of convenience. Those 2 salts of penicillin are formulated to release penicillin slowly and to allow for administration twice daily, once daily, or even every third day. This extended release is a pharmacologic enhancement of the potential for residues in the injection site and more distant tissues. We are unaware of specific studies to evaluate the effect of dose form (specifically sustained release) on the correctness of the withdrawal period specified for that dose form, using current USDA/FSIS analytic techniques.

Recommendation: Surveys of residue incidence by regulatory agencies should continue. Reliable estimates of sales volumes for food animal pharmaceuticals should be sought. Funds also should be made available for the pharmacokinetic investigations of specific drugs and dose forms. Large-scale field comparisons of alternatives to sulfamethazine should be conducted. In veal calves, residues created by oral administration of neomycin deserve particular attention. Finally, careful attention should be paid to residue incidence associated with the administration of drugs such as ceftiofur sodium (others would include amoxicillin injection, sodium ampicillin, and sodium penicillin G). Its absorption and elimination characteristics make it an attractive prototype for food animal drug development. It seems likely that drugs that are rapidly absorbed and only slightly less rapidly eliminated (within reason) should be infrequently associated with residues.

ROUTE OF ADMINISTRATION

Hypothesis: Certain routes or methods of administration are associated with higher than average risk of drug residues.

Most likely, the association between injectable drugs and residues is confounded by the relatively high numbers of dairy cows in this study opposed to the numbers, for example, of veal calves and market hogs in the population described by the USDA/FSIS Monitoring Program reports. Dairy cows are more likely to receive injectable medications, rather than oral, as they are more likely to receive therapeutic antibiotics (which are usually given by injection) rather than antibiotics that enhance performance (which are usually given orally). Also, a greater emphasis might have been placed on therapeutic drugs in the case selection process, or injection site lesions and associated residues might have biased the process. Finally, the relative incidence of residues from injection sites rather than other tissues is not clearly available from the investigative reports (FDA/CVM and VDACS). We hasten to point out that such information is available if one investigates each tissue in the FSIS tissue analysis database.

The rather surprising incidence of neomycin residues in calves after oral administration of the drug suggests, of course, that the calf is absorbing neomycin from medicated feed mixtures. Further evaluation of this practice is necessary to interpret this finding. Restrictions on age or disease process or a discontinuation of the practice could be in order.

Finally, surveys of this type are useful for identifying unanticipated events such as the production of residues by feeding milk that was withheld from sale for residues. It is important to identify and eliminate similar inadvertent residue-creating situations.

Recommendation: Both population and pharmacokinetic analysis of specific routes and methods of drug administration associated with an increased risk of drug residues should be conducted. Educational efforts should be directed toward enhancing the general level of knowledge of these associations.

MARKET CLASS

Hypothesis: A limited number of market classes, namely, veal calves, market hogs, and cull dairy cows, should be viewed as problem areas.

An independent evaluation of residue incidence by market class also came from a summation of the USDA/FSIS Monitoring Program.[2,3] The analysis of FDA/CVM and VDACS suggests that the most prevalent groups, in ascending rank order, are cows, calves, and market hogs. Although rank order in the population analyzed by USDA was somewhat different in that calves had the highest incidence of antibiotic residues and hogs had the highest incidence for sulfonamide residues, the monitoring program confirms that veal calves, market hogs, and cull dairy cows account for most drug residue problems.

Recommendation: Special attention should be given to those market classes and operation types that lead to the majority of drug residues in food animals. Regulatory efforts and those of veterinary and producer organizations should be targeted at specifically identified industry segments.

CAUSES FOR DRUG RESIDUES

Hypothesis: The dominant cause of drug residues is failure to observe withholding time. In many cases, the individual responsible for the residue was unaware of the correct drug withdrawal time.

In our study, failure to follow withdrawal time was cited as a cause for the drug residue in 69.1% (FDA/CVM) and 94.3% (VDACS) of the investigations conducted when cause was known. When only those records indicating this cause were considered, the withdrawal time was allegedly unknown 50% (FDA/CVM) and 82% (VDACS) of the time. Analysis of a similar group of field investigations conducted by FDA/CVM personnel for fiscal year 1985 (hereafter referred to as FY85) revealed that 51.32% of the reports for which cause was determined listed failure to observe withdrawal time as a cause of drug residue.[11] An evaluation of records from Michigan dairy herds also supports this observation, and the percentage of cows culled before withdrawal periods elapsed was 3.76% of all cows culled during the period of study. Taken together, these findings suggest that, for some cases, current procedures for dissemination of information fail.[12] They are further supported by a survey of dairy farmers in Michigan who cited "insufficient knowledge about withdrawal periods" as the leading cause of drug residues in milk.[13]

Whoever logically should educate the animal owner often fails to do so. Whether the privately practicing veterinarian, the drug company, the wholesale or retail distributor, the feed mill, or the FDA/CVM should be accountable in any given case is not important. The fact is, the owner of the animal often does not know the withdrawal time. This finding opens a window of opportunity for the private veterinary practitioner, who is the most logical source of drug information for the food animal producer. A system that identifies this relationship for the producer, rewards the producer and veterinarian for their mutual participation, and prepares the veterinarian for the role would be of benefit to fill this gap.

Conversely, of course, the known withdrawal time was known and disregarded in 50% (FDA/CVM) and 18% (VDACS) of the reports. Even when withdrawal times are known, poor to mistaken records, incorrect animal identification, or simple inattention will lead to a few violations. Finally, intentional violations of the withdrawal period will occur. Eliminating these latter causes for residues is a more daunting challenge for the food animal industry.

Failure to follow label directions and failure to follow the directions of a veterinarian are listed as causes of residues in a substantial number of cases (Table 3). The additional significance of either finding is dubious because, as will be discussed later, failure to follow withdrawal information is the leading type of "failure to follow label directions." Further, failure to follow label directions is cited as a sole cause in only 3 records in the FDA/CVM database. This information was not a part of the FDA/CVM FY85[11] study.

Recommendation: Veterinarians, the AVMA, and food animal specialty groups should be actively involved in education of the food animal industry.

Hypothesis: Poor production practices, associated primarily with inadequate medication records, contribute to the incidence of drug residues.

In 14.5% of FDA/CVM and 20.8% of VDACS reports, poor production practices, usually poor record keeping, were cited as causes of drug residues. Of the reports analyzed for the CVM FY85 study, 9 also cited poor record keeping as a cause of drug residue. In the latter study, poor record keeping was listed as the sole identifiable cause in only 1 report, and so is considered (by the authors of the FY85 study and by us) to be a contributing, rather than a primary, cause. This association comes as no surprise to anyone familiar with the delivery of animal health care in the United States. Complete medication records (which should include dates of administration, routes and sites, numbers and sizes of doses, and approximate weight of the animal treated) have only recently become standard practice for farming enterprises. They are not universally maintained. Medication records maintained by individuals and provided at the time of sale would improve our understanding of the problem and should directly reduce the incidence of drug residues. This statement is based on the previously discussed observation that failure to observe withdrawal time, even when that withdrawal time was known, was the most prevalent cause of drug residues.

Recommendation: Educational efforts should emphasize the importance of record keeping, including efforts to identify animals from their source to their entry into the food chain.

Hypothesis: Some fraction of residues will persist despite attention to appropriate withdrawal time.

The use of the drug product was in accordance to label directions in 11 (FDA CVM) and 4 (VDACS) reports in the respective databases. Experimental evidence also supports the notion that attention to published withdrawal times may not be sufficient for residue prevention. In a study of 58 lactating dairy cows, composite milk samples were evaluated 72 hours after treatment and at 24-hour intervals until the sample no longer contained antibiotic, as detected by the *Bacillus stearothermophilus* disk assay.[14] Of 10 cows treated with intramammary cephaparin[a] according to label directions, 4 had residues persisting beyond the stated withdrawal period. Although the investigators noticed that their assay was more sensitive than that used to establish the withdrawal period, their study points to a need for similar investigations of other drugs.

Although major changes in attention to withdrawal times and medication records will likely eliminate much of the drug residue incidence, drug residues will still be a problem. Biologic variability associated with the whole population of food animals will almost ensure this. Further, certain diseases (eg, inadequate renal function, ample dehydration) and drug administration practices (eg, failure to rotate injection sites sufficiently, injection into fat rather than muscle) will contribute directly to the problem. Identification of confounding pharmacokinetic factors such as bioavailability, absorption rates, selection of appropriate routes, and injection sites is an important issue.

Recommendation: Studies of the appropriateness of stated withdrawal periods should be conducted for a number of drug products used in food animals.

Hypothesis: Unapproved drug use is a minor contributing factor to the incidence of residues in food animals.

As determined in our study, only a limited subset of records (10 in all) included unapproved drug use as a cause of residues. This was listed as the sole cause in only 1 record in either study. The CVM FY85 study reported this cause in 17 (11%) records. Whether this was a sole or contributing cause in this larger percentage is unknown. Neither study gives a valid assessment of the direct effect of unapproved use on the incidence of drug residues.

Drug residues are a result of the failure of the elimination of the drug from the edible portions of food animals. This is consistent not only with a reasonable toxicologic and pharmacologic approach to drug residues, but is also in keeping with current regulatory posture concerning so-called extra-label use, provided that it is in the confines of an appropriate client/veterinarian/patient relationship. Unapproved use should not be considered a primary cause of illegal residues. Complete documentation of this use, including route, dose, and withdrawal time and any directions given by veterinarians, is critical information if extra-label drug uses continue as a part of food animal therapeutics.

Recommendation: Prospective analysis of residue incidence after certain extra-label drug uses should be undertaken. Further, funding should be made available for appropriate pharmacokinetic investigations of extra-label uses of pharmaceuticals in food animals.

RESPONSIBILITY

Hypothesis: The owner of the animal involved is the one making decisions to treat and to sell the animals. As a consequence, the owner of the animal bears dominant responsibility for any residues that are created.

The results of this study indicate that, in the opinion of the field investigator, the owner of the animal bore responsibility for drug residues in an overwhelming majority of reports in which responsibility was established (Table 5). The FDA/CVM FY85 study did not include an evaluation of responsibility for the residue. These results are not particularly surprising. Given the association between withdrawal time and drug residues, the decision to sell the animal at some point after treatment likely would have the greatest overall effect. Among private operators (dairy farms and on-farm producers made up over 60% of known operations), the decision to sell may be made in consultation with others, but the decision is still their own.

---

[a] Cefa-Lak, Sodium Cephapirin, Bristol Laboratories, Syracuse, NY.

In the present regulatory environment, the food animal owner will retain considerable privilege to purchase and administer therapeutic drugs. It seems a reasonable assumption that a veterinarian is in an ideal position to give counsel to the animal owner concerning appropriate indications, administration, and withdrawal period. The food animal veterinarian is the producer's most logical source for scientific information that will aid in therapeutic decision making.

Recommendation: The AVMA and the food animal specialty groups should direct considerable effort toward expanding, first, the food animal veterinarian's ability to give correct and useful scientific therapeutic guidance, and, second, the food animal veterinarian's visibility as a logical point of positive focus for the profession's efforts designed to curb drug residues.

References

1. Phillips L. Misery on the menu. *Large Anim Vet* 1989;Jan-Feb:26, 28.

2. Miller WR. *1983 Domestic residue data book national residue program: antibiotics and sulfonamides*. Washington, DC: USDA-FSIS, 1986.

3. Miller WR. *1984 Domestic residue data book national residue program: antibiotics and sulfonamides*. Washington, DC: USDA-FSIS, 1986.

4. Miller WR. *1985 Domestic residue data book national residue program: antibiotics and sulfonamides*. Washington, DC: USDA-FSIS, 1987;27-49.

5. Miller WR. *1986 Domestic residue data book national residue program: antibiotics and sulfonamides*. Washington, DC: USDA-FSIS, 1987.

6. Brown J, ed. *Compound evaluation and analytical capability national residue program plan*. Washington, DC: USDA-FSIS, 1987; Section 2(1).

7. Cordle MK. USDA regulation of residues in meat and poultry products. *J Anim Sci* 66:413-433.

8. National Animal Health Monitoring System. *Michigan Report—round 1 final report 1986-1987. Michigan State University, College of Veterinary Medicine, Division of Epidemiology*. Washington, DC: USDA-APHIS, Veterinary Services, xxxx.

9. Pottle FC. *Final veterinary drug report—Colorado*. Denver: Consumer Protection Division, Colorado Department of Health, 1987.

10. Booth NH. Drug and chemical residues in the edible tissues of animals. In: Booth NH, McDonald LE, eds. *Veterinary pharmacology and therapeutics*. 6th ed. Ames, Iowa: 1988;1149-1205.

11. Paige JC. Tissue residue briefs. *FDA Vet* 1987;2(6):10-11.

12. Marteniuk JV, Ahl AS, Bartlett PC. Compliance with recommended drug withdrawal requirements for dairy cows sent to market in Michigan. *J Am Vet Med Assoc* 1988;193:404-407.

13. Kaneene JV, Alwynelle S. Drug residues in the dairy cattle industry: epidemiological evaluation of factors influencing their occurrence. *J Dairy Sci* 1987;70:2176-2180.

14. Seymour EH, Jones GM, McGilliard ML. Persistence of residues in milk following antibiotic treatment of dairy cattle. *J Dairy Sci* 1988;71:1691-1699.

Economic Note

1987 Gross practice income attributable to veterinary service and product categories

The AVMA's 1988 Biennial Economic Survey of veterinarians included the following question: "What was your 1987 gross practice revenue for each of the following service and product categories?"[1] Twelve categories were listed: professional services (office/farm calls including examination, consultation); surgery; radiology; laboratory/diagnostics; hospitalization; vaccinations; dentistry; nonprofessional services (eg, medicated baths, dips, groomings, boardings); product sales, drugs/medications; product sales, nondrug products (eg, nutritional products, animal care supplies); mileage; miscellaneous.

The mean percentage of 1987 gross practice revenue attributable to each service and product category was computed and weighted according to the proportion of practices that indicated a percentage of revenue for each category. Results in Table 1 show mean weighted percentages; thus, percentages illustrate a composite of veterinary practice revenue for each type of practice.

Table 1—Percentage of 1987 gross practice income attributable to veterinary service categories

Service category	Large animal exclusive (%)	Large animal predominant (%)	Mixed animal (%)	Small animal predominant (%)	Small animal exclusive (%)	Equine predominant (%)
Professional services	59*	39	33	26	22	41
Surgery	3	5	11	17	16	10
Radiology	1	1	3	4	5	7
Laboratory/diagnostics	2	2	4	6	8	6
Hospitalization	†	†	3	6	6	2
Vaccinations	4	8	8	7	8	5
Dentistry	†	†	2	2	3	2
Nonprofessional services	†	1	3	7	7	†
Sales: Drugs/medications	25	35	23	14	14	13
Sales: Nondrug products	1	3	3	4	6	2
Mileage	3	4	4	2	†	6
Miscellaneous	1	2	3	3	4	5

*Weighted mean percentages to represent percentage distribution of revenue of "composite veterinary practice."
†Weighted mean percentage is <1%.

Professional services accounted for the largest percentage of 1987 gross practice revenue across all practice types, ranging from 22% in small animal exclusive practice to 59% in large animal exclusive practice. Across all types of practice, professional service accounted for 29% of gross practice revenue in 1987—2 percentage points lower than reported for 1981.[2]

Sales of drugs and medications accounted for approximately 18% of 1987 gross practice income, ranging from a low of 13% for equine practice to a high of 35% for large animal predominant practice. In small animal predominant and small animal exclusive practice, drugs/medication sales were 14% of gross practice revenue. Sales of nondrug products ranged from 1 to 2% in large animal exclusive and equine practice to 6% of revenue in small animal exclusive practice.

Surgery revenue accounted for 16% and 17% of small animal exclusive and small animal predominant practice, respectively. Surgery represented 3% and 5% of revenue in large animal exclusive and large animal predominant practice, respectively.

Each of the remaining revenue categories accounted for < 10% of gross revenue.

Prepared by J. Karl Wise, PhD, Wisemark Associates, PO Box 681189, Schaumburg, IL 60168-1189.

This report is the fifth in a series of monthly Economic Notes summarizing results of the 1988 AVMA Biennial Economic Survey.

---

1. Wise JK. 1987 incomes of US veterinarians. *J Am Vet Med Assoc* 1989;194:563-566.

2. Wise JK. Veterinary service categories and 1981 gross practice income. *J Am Vet Med Assoc* 1983;182:822.

A3100-2

July 15, 1989, Volume 195, Number 2

JOURNAL OF THE AMERICAN VETERINARY MEDICAL ASSOCIATION

Forum

National Board Examination revisited 166

Food for thought for food animal veterinarians

One bad apple affects a barrel of apples 168

Letter

Bovine somatotropin and nutrient density 169

Council Report

AVMA guidelines for dealing with AIDS-infected persons in the veterinary workplace 190

The *Human* Side of Veterinary Medicine

The previous veterinarian 194

Risk factors for lower respiratory tract disease in a cohort of feedlot cattle 207

800155262 1 071539 2 23 J
CONGRESSIONAL INFO SERV **
MR ED KIANKA STAT REF INDEX **
4520 EAST WEST HWY **
BETHESDA MD 20814 **

JOURNAL
OF THE AMERICAN VETERINARY MEDICAL ASSOCIATION

© American Veterinary Medical Association, 1989
All Rights Reserved

Vol 195 July 15, 1989 No. 2
JAVMA 195 (2) 161-280 (1989)
ISSN 0003-1488

Interpretive Summaries of Articles in This Issue 164

Letters

Bovine somatotropin and nutrient density 166
"He would always want me to care, always to care" 167
Residencies and advanced degrees 167
Human anthrax 167

Food for thought for food animal veterinarians

One bad apple affects a barrel of apples—*John B. Herrick* 168

Guest Editorial

Challenges to veterinary constituencies flowing from the PNVEP study: An epilogue—*William Pritchard* 170

News

Edge of Education—Veterinary education programs for the 21st Century 171
AVMA at Work—Animal welfare issues addressed 175
AVMA supports proposed rulings 178
Committee seeks new veterinary employment opportunities 180
Regulatory Front 181
Practice Management Corner—How do employees feel about working in a veterinary practice? 182
Awards and Honors 183
Student and School Scenes Student AVMA convenes at NCSU 184
Out and About Veterinarian has date with space 185
Deaths 186

Forum

National Board Examination revisited—*R. Leland West* 188

Council Report

AVMA guidelines for dealing with AIDS-infected persons in the veterinary workplace 190

The *Human* Side of Veterinary Medicine

The previous veterinarian—*Jacob Antelyes* 194

Special Commentary

Zoologic medicine, comparative medicine, and veterinary medical education—*Howard D. Martin* 196

Food Animal Economics

Use of the partial farm budget technique to predict the economic impact of the flock management decision to use B-mode ultrasonographic pregnancy diagnosis—*D. J. Sprecher, W. B. Ley, W. D. Whittier, J. M. Bowen, C. D. Thatcher, K. D. Pelzer, and J. M. Moore* 199

Reports of Original Studies

Risk factors for lower respiratory tract disease in a cohort of feedlot cattle—*B. H. Alexander, D. W. MacVean, and M. D. Salman* 207
Clinical use of the neuromuscular blocking agents atracurium and pancuronium for equine anesthesia—*S. V. Hildebrand, M. Holland, V. S. Copland, D. Daunt, and N. Brock* 212
Use of radionuclide imaging to identify malignant mammary tumor bone metastases in dogs—*Gregory K. Ogilvie, Roger V. Allhands, and H. A. Reynolds* 220

Clinical Reports

Caval syndrome in a *Dirofilaria immitis*-infected dog treated with dichlorvos—*Kathryn A. Eaton and Thomas J. Rosol* 223
Bilateral conjunctival masses in two dogs—*Christopher J. Murphy, Roy W. Bellhorn, and Nedim C. Buyukmihci* 225
Pulmonary atresia with intact ventricular septum and agenesis of the ductus arteriosus in a pup—*Donald J. Brown and Donald F. Patterson* 229
Atlantoaxial subluxation and absence of transverse ligament of the atlas in a dog—*Alastair G. Watson and Alexander de Lahunta* 235

Primary teat neoplasia in two yearling heifers—*Troy S. Ford, Michael W. Ross, Helen M. Acland, John B. Madison* 238

Tarsal fractures in a heifer and a bull—*F. H. Welker, P. D. Modransky, D. M. Rings, and B. L. Hull* 240

Reports of Retrospective Studies

Neurologic abnormalities as the predominant signs of neoplasia of the nasal cavity in dogs and cats: Seven cases (1973-1986)—*M. O. Smith, Jane M. Turrel, Cleta Sue Bailey, and Gary R. Cain* 242

Pulmonary thromboembolism associated with immune-mediated hemolytic anemia in dogs: Ten cases (1982-1987)—*Mary Kay Klein, Steven W. Dow, and Rodney A. W. Rosychuk* 246

Economic Note

Size and practice density of local veterinary service areas, 1988—*J. Karl Wise* 251

What Is Your Diagnosis?

Paul E. Howard and John L. Scheels 253

Book Reviews

Sarcocystosis of Animals and Man 228
Veterinary Clinical Immunology: From Classroom to Clinics 234
The Domestic Cat: The Biology of Its Behaviour 250

Abstracts of Selected Reports

Prevalence of *Cryptosporidium* infection in dairy calves in western Washington 211
Effects of intermittent and continuous administration of decoquinate on bovine coccidiosis in male calves 219
Serum chemical profile of feeder pigs, as influenced by market stress and feeding regimen 241

Announcements

Certification Examinations 205
Coming Meetings 255
Foreign Meetings 257
Educational Opportunities 258
Applications for Membership 259

Classified Ads 261

Coming Soon . . .

August 1

Edge of Education—Learning to learn

Topics in Drug Therapy—Use of α_2-adrenergic receptor antagonists (M. E. Gross and W. J. Tranquilli)

Reflections—Why do we become veterinarians? (W. O. Keefer)

Council Report—Canine and feline immunization guidelines

Legal Brief—Veterinary medical associations, state, government, and the courts (H. W. Hannah)

August 15

Research Roundup—Swine reproductive failure syndrome mystifies scientists

The *Human* Side of Veterinary Medicine—Emotion: The inescapable element in practice (J. Antelyes)

Council Report—AVMA guide for veterinary medical waste management

Economic Note—Fringe benefits received by veterinarians, 1987 (J. K. Wise)

Evaluation of heparin for prophylaxis of equine laminitis (J. K. Belknap and J. N. Moore)

Economic Note

Size and practice density of local veterinary service areas, 1988

To understand more about the distribution of US veterinary practices and their geographic market areas, the 1988 AVMA Biennial Economic Survey included 3 questions that focused on a practice's community size, the mile radius of the geographic veterinary service area, and the number of other practices within the defined veterinary service area providing the same type of veterinary services.[1]

The percentage distribution of US veterinary practices was estimated by type of practice for 6 community sizes: rural area (less than 2,500 population); small town (2,500 to 50,000); moderate-size urban area (50,001 to 500,000), city and suburb; and large-size urban area (500,001 or more), city and suburb (Table 1).

Table 1—Percentage distribution of US veterinary practices by community size, 1988

	Equine predominant (%)	Large animal exclusive (%)	Large animal predominant (%)	Mixed animal (%)	Small animal predominant (%)	Small animal exclusive (%)
Rural area (less than 2,500)	8.4	27.2	50.1	22.0	10.1	4.5
Small town (2,500 to 50,000)	35.7	47.4	44.8	64.7	63.3	37.3
Moderate urban (50,001 to 500,000)						
City	3.5	3.5	1.8	2.4	7.9	14.6
Suburb	25.9	14.9	2.3	9.2	10.1	17.9
Large urban (500,001 or more)						
City	8.4	1.0	0.5		3.2	13.1
Suburb	18.2	5.3	0.5	0.5	4.7	11.9
Total	100.0 (143)*	100.0 (114)	100.0 (221)	100.0 (207)	100.0 (316)	100.0 (268)

*Number of usable responses

Table 2—Distribution of US veterinary practices by community size, 1981-1988

	Equine predominant (%)		Large animal exclusive (%)		Large animal predominant (%)		Mixed animal (%)		Small animal predominant (%)		Small animal exclusive (%)	
	1981	1988	1981	1988	1981	1988	1981	1988	1981	1988	1981	1988
Rural area and small town (less than 50,000)	39	44	87	75	96	95	87	87	77	74	30	42
Moderate urban (50,001 to 500,000)	34	29	9	19	3	4	11	12	19	18	39	33
Large urban (500,001 or more)	27	27	4	6	1	1	2	1	4	8	31	25
Total	100	100	100	100	100	100	100	100	100	100	100	100

A comparison of the 1988 distribution of veterinary practices across community sizes with the corresponding 1981 distribution suggests that certain shifts have taken place from 1981 to 1988 (Table 2).[2] The proportion of equine practices in rural areas and small towns has increased from 39 to 44% from 1981 to 1988, and in moderate-size urban areas has decreased from 34 to 29%. Also, the distribution of large animal exclusive practices has shifted somewhat from rural areas and small towns to moderate-size urban areas. Specifically, the proportion of large animal exclusive practices located in moderate size urban areas has increased from 9% in 1981 to 19% in 1988.

In Table 2, results also suggest that there has been a shift in the distribution of small animal exclusive practices from moderate- and large-size urban areas to rural areas and small towns. Specifically, the proportion of small animal exclusive practices located in rural areas and small towns has increased from 30% in 1981 to 42% in 1988. Likewise, the proportion of small animal exclusive practices in

---

Prepared by J. Karl Wise, PhD, Wisemark Associates, PO Box 681189, Schaumburg, IL 60168-1189.

This report is the sixth in a series of monthly Economic Notes summarizing results of the 1988 AVMA Biennial Economic Survey.

moderate- and large-size urban areas has decreased from 70% in 1981 to 58% in 1988.

Size of veterinary service area was related to practice type and community size (Table 3). Veterinary service area was defined as the mile radius of the area that composed 75% of the practices's clients. For all community sizes, the mean mile radius for a practice area ranged from a high of 31 miles for large animal exclusive practices to a low of 11 miles for small animal exclusive practices. The mean mile radius for large animal exclusive and small animal exclusive practices increased from 1981 to 1988, consistent with the shift of large animal practices to more urban locations, and the shift of small animal practices to less urban areas.

From AVMA's 1988 Biennial Economic Survey, it was determined that the mean number of other practices providing the same type of veterinary service (ie, large, small, or equine) within the defined veterinary service area ranged from a low of 4 practices for large animal predominant to a high of 10 practices for equine predominant (Table 4). Across practice types, there were approximately 4 other similar practices in the defined veterinary service area for practices located in rural areas and small towns. In large population areas, the mean number of similar practices in the defined veterinary service area ranged as high as 9 small animal practices, and 17 equine practices.

Table 3—Size of veterinary service area by practice type and community size, 1988

	Equine predominant (mile radius)*	Large animal exclusive (mile radius)	Large animal predominant (mile radius)	Mixed animal (mile radius)	Small animal predominant (mile radius)	Small animal exclusive (mile radius)
Rural area (less than 2,500)	26	26	21	21	19	17
Small town (2,500 to 50,000)	29	35	24	22	17	13
Moderate urban (50,001 to 500,000)						
City	26			25	9	9
Suburb	24	30	36	18	14	8
Large urban (500,001 or more)						
City	24				15	8
Suburb	27				11	10
All areas	27	31	23	21	16	11

*Mean mile radius of veterinary service area that composes 75% of the practice's clients.

Table 4—Mean number of similar practices in the defined veterinary service area, 1988

	Equine predominant (%)	Large animal exclusive (%)	Large animal predominant (%)	Mixed animal (%)	Small animal predominant (%)	Small animal exclusive (%)
Rural area (less than 2,500)	7*	4	4	4	3	4
Small town (2,500 to 50,000)	7	5	3	5	4	5
Moderate urban (50,001 to 500,000)						
City	3			11	8	9
Suburb	12	5	5	7	9	6
Large urban (500,001 or more)						
City	17				4	8
Suburb	10				9	6
All areas	10	5	4	5	5	6

*Mean number of practices located within defined veterinary service area that provide the same type of veterinary service. Defined veterinary service area is the mean mile radius of veterinary service area that composes 75% of the practice's clients.

References

1. Wise JK. 1987 income of US veterinarians. *J Am Vet Med Assoc* 1989;194:563-566.

2. Wise JK. Size and practice density of local veterinary service areas. *J Am Vet Med Assoc* 1983;183:233-234.

A3100-2

August 15, 1989, Volume 195, Number 4

JOURNAL OF THE AMERICAN VETERINARY MEDICAL ASSOCIATION

Research Roundup

Swine reproductive failure syndrome mystifies scientists 425

Food for thought for food animal veterinarians

Suppliers of food animal health products are changing 438

Council Report

AVMA guide for veterinary medical waste management 440

The *Human* Side of Veterinary Medicine

Emotion: The inescapable element in practice 453

Zoonosis Update

Salmonellosis 456

Economic Note

Fringe benefits received by veterinarians, 1987 521

JOURNAL
OF THE AMERICAN VETERINARY MEDICAL ASSOCIATION

© American Veterinary Medical Association, 1989
All Rights Reserved

Vol 195 August 15, 1989 No. 4
JAVMA 195(4) 417-552 (1989)
ISSN 0003-1488

Interpretive Summaries of Articles in This Issue 420

Letters

Confinement rearing of calves 423
Etymologic considerations 423
Urine odor eliminators 424

News

Research Roundup—Swine reproductive failure syndrome mystifies scientists 425
Student and School Scenes 428
AVMA at Work—JAVMA initiates computer-scannable strips for literature search 429
Call for speakers: 1990 AVMA convention 430
Edge of Education—Discussions at 10th Symposium inspired by Pew report 431
Chemical impairment prevention is topic at 10th Symposium 431
Washington Watch—FDA advisory group meets 432
AVMA urges inspection of seafood products 432
AVMA supports legislation to end research vandalism 433
Pages from the Past—John Hunter and Mrs. General Pitt's horse 434
Out and About—Pets donate blood to Angell Memorial 436
Deaths 436

Food for thought for food animal veterinarians

Suppliers of food animal health products are changing—*John B. Herrick* 438

Council Report

AVMA guide for veterinary medical waste management—*Marcia D. Brody and Sue Markland* 440

The *Human* Side of Veterinary Medicine

Emotion: The inescapable element in practice—*Jacob Antelyes* 453

Zoonosis Update

Salmonellosis—*Kevin D. Pelzer* 456

Food Animal Economics

Decision-tree analysis of treatment alternatives for left displaced abomasum—*P. L. Ruegg and T. E. Carpenter* 464

Reports of Original Studies

Autogenous lamellar corneal grafting in dogs—*Alan H. Brightman, Susan A. McLaughlin, and J. Daniel Brogdon* 469
Epidemiologic investigation and control of an epizootic of anaplasmosis in cattle in winter—*R. D. Smith, L. L. Hungerford, and C. T. Armstrong* 476
Compensatory weight gain in steers recovered from oak bud toxicosis—*Stephanie R. Ostrowski, Bradford P. Smith, Sharon J. Spier, Ben B. Norman, and Michael N. Oliver* 481

Clinical Reports

Apparent toxicosis associated with lily-of-the-valley *(Convallaria majalis)* ingestion in a dog—*Rodney A. Moxley, Norman R. Schneider, Donald H. Steinegger, and Michael P. Carlson* 485
Disseminated adenocarcinoma with ocular involvement in a cat—*Christopher J. Murphy, David C. Canton, R. W. Bellhorn, Mark Okihiro, Brad Cahoon, and Robert Dufort* 488
Treatment of teat obstruction in a cow by transfer of oral mucosa and temporary implantation of an intraluminal tube—*David G. Bristol* 492
Lateral luxation of the superficial digital flexor tendon from the calcaneal tuber in two horses—*D. M. Meagher and A. V. Aldrete* 495
Percutaneous nephrostomy in short-term management of ureterolithiasis and renal dysfunction in a filly—*T. D. Byars, J. S. Simpson, T. J. Divers, K. A. Shiner, and N. W. Rantanen* 499
Postanesthetic compartmental syndrome in a horse—*Wendy M. Norman, Rosemarie Williams, Nicholas H. Dodman, and Ann E. Kraus* 502

Reports of Retrospective Studies

Evaluation of heparin for prophylaxis of equine laminitis: 71 cases (1980-1986)—*James K. Belknap and James N. Moore* 505

Intestinal atresia in calves: 22 cases (1978-1988)—*Daniel J. Dreyfuss and Eric P. Tulleners* 508

Review Article

Ultrasonography of noncardiac thoracic diseases in small animals—*Jonathan L. Stowater and Christopher R. Lamb* 514

Economic Note

Fringe benefits by veterinarians, 1987—*J. Karl Wise* 521

What Is Your Diagnosis?

Gary M. Baxter 523

Book Reviews

Magrane's Canine Ophthalmology 475
Small Animal Ophthalmology: A Problem-Oriented Approach 487
Current Veterinary Therapy X 520

Abstracts of Selected Reports

Effect of vaccination with a bacterin containing *Leptospira interrogans* serovar *bratislava* on the breeding performance of swine herds 501
Effectiveness of two benzathine cloxacillin formulations for treatment of naturally occurring infectious bovine keratoconjunctivitis 513

Announcements

Coming Meetings 525
Foreign Meetings 527
Applications for Membership 527
Certification Examinations 528
State Board Examinations 528
Educational Opportunities 529

Classified Ads 532

Correction

July 1 About the cover 484

Coming Soon . . .

September 1

Zoonosis Update—Brucellosis (R. W. Currier)

Special Report—Evaluation of practical dry dog foods suitable for all life stages (G. L. Czarnecki-Maulden)

Clinical signs associated with pseudorabies in dogs (W. E. Monroe)

Field trial of theophylline in cattle with respiratory tract disease (D. J. McKenna et al)

Veterinarians Afield—Volunteer work spans three continents

September 15

Food for thought for food animal veterinarians—Preconditioning did not sell—perhaps quality assurance would (J. B. Herrick)

Special Report—Patterns of ionizing radiation exposure among women veterinarians (S. A. Moritz et al)

Regional distribution of ten common skin diseases in dogs (W. M. Sischo et al)

Orlando convention wrapup . . .

Economic Note

Fringe benefits received by veterinarians, 1987

Fringe benefits represent employment benefits that are paid by the employer in addition to an employee's salary. In the 1988 AVMA Biennial Economic Survey, veterinarians were asked to indicate which of the following fringe benefits were provided by their practice or employer in 1987: life insurance, medical plan, dental plan, pension plan, disability insurance, liability insurance, association dues, continuing education expenses, personal use of vehicle, lodging, and miscellaneous benefits.[1] Respondents also indicated if no fringe benefits were provided. Also, respondents were requested to report the total dollar value of their fringe benefits received in 1987. That is, if they received fringe benefits, what would those fringe benefits have cost them if they had to pay for them.

Types of fringe benefits

Fringe benefits mentioned most often by private practitioners were expenses for continuing education and association dues, 66%; liability insurance, 58%; and medical plan, 53% (Table 1). Other benefits mentioned included disability insurance, 40%, and life insurance, 34%. Personal use of automobile and lodging were also indicated by many respondents; however, because of probable confusion with reimbursement and use during travel away from the practice, these benefits were not included in this analysis.

Table 1—Percentages of veterinarians receiving fringe benefits—private practice, 1987

Fringe benefits	Large animal exclusive %	Large animal predominant %	Mixed animal %	Small animal predominant %	Small animal exclusive %	Equine predominant %	All practices* %
Life insurance	35.3	36.2	33.4	31.4	32.9	43.0	33.9
Medical plan	51.6	49.7	55.4	48.4	53.5	57.0	52.6
Dental plan	11.8	5.9	6.4	5.1	8.7	10.1	7.8
Pension plan	27.5	21.4	16.6	18.0	20.0	21.1	20.0
Disability insurance	49.0	40.7	43.2	42.3	37.2	49.1	40.2
Liability insurance	65.4	64.1	59.1	60.6	54.3	71.5	58.5
Association dues	59.5	67.9	58.4	66.9	66.5	64.0	65.6
Continuing education expenses	62.7	65.2	60.8	67.4	67.1	66.2	66.1
Other	2.6	2.8	2.7	2.2	4.9	1.8	3.7
None provided	20.3	16.9	17.6	16.3	16.1	14.9	16.6
	(153)†	(290)	(296)	(411)	(529)	(228)	

*Weighted percentages for the total population of private practitioners. †Number of usable responses in parentheses.

Table 2—Percentages of veterinarians receiving fringe benefits—nonprivate practice, 1987

Fringe benefits	College or university %	Federal government %	State or local government %	Armed Forces %	Industry/ commercial %	All employers* %
Life insurance	69.9	63.8	64.0	58.4	76.5	68.1
Medical plan	89.4	78.3	95.5	97.5	94.6	89.1
Dental plan	56.9	50.4	61.0	92.9	71.8	59.5
Pension plan	80.1	85.8	92.3	84.5	75.8	79.8
Disability insurance	60.2	40.8	44.1	44.1	68.5	55.4
Liability insurance	37.8	5.4	23.1	13.0	28.2	27.4
Association dues	10.6	2.9	19.8	0.4	71.8	24.1
Continuing education expenses	50.0	38.8	50.6	83.2	74.5	55.4
Other	3.7	5.4	8.5	7.6	14.1	7.0
None provided	2.4	5.0	1.2	1.3	4.7	3.8
	(246)†	(240)	(247)	(238)	(149)	

*Weighted percentages for the total population of veterinarians not in private practice. †Number of usable responses in parentheses.

A comparison to 1980 data indicates that more private practitioners received fringe benefits in 1987 than in 1980.[2] For all private practitioners, 16.6% indicated that they did not receive fringe benefits in 1987, compared with 26.0% in 1980. The most notable increase was for private practitioners receiving medical plan benefits, which increased from 43% in 1980 to 53% in 1987.

For veterinarians not in private practice, fringe benefits mentioned most frequently were

---

Prepared by J. Karl Wise, PhD, Wisemark Associates, PO Box 681189, Schaumburg, IL 60168-1189.

This report is the seventh in a series of monthly Economic Notes summarizing results of the 1988 AVMA Biennial Economic Survey.

medical plans, 89%; pension plans, 80%; life insurance, 68%; dental plans, 59%; disability insurance, 55%; and continuing education expenses, 55%. As with the private practice group, more veterinarians not in private practice received fringe benefits in 1987 than in 1980 (Table 2). Dental plan benefits increased the most, increasing from 35% in 1980 to 59% in 1987. For all nonprivate practitioners, 3.8% indicated that they received no fringe benefits in 1987.

Values of fringe benefits

The mean value of fringe benefits reported by veterinarians in private practice in 1987 was $4,785, ranging from a low of $3,911 for mixed animal practitioners to a high of $6,309 for equine practitioners (Table 3). The mean value of fringe benefits expressed as a percentage of mean professional income showed only slight variation, ranging from 9.0% for large animal exclusive and large animal predominant practitioners to 11.0% for equine practitioners.[3] For all private practitioners, fringe benefits as a percentage of mean professional income increased from 9.7% in 1980 to 10.2% in 1987.

Table 3—Dollar values and percentages of fringe benefits received by veterinarians in private practice, 1987

	Large animal exclusive	Large animal predominant	Mixed animal	Small animal predominant	Small animal exclusive	Equine predominant	All practices
Mean professional income ($)	54,659	46,149	40,796	43,784	46,866	57,196	46,692
Mean value of fringe benefits ($)	4,943	4,137	3,911	4,116	4,862	6,309	4,785
Mean value of fringe benefits as a percentage of mean professional income (%)	9.0	9.0	9.6	9.4	10.4	11.0	10.2

Table 4—Dollar values and percentages of fringe benefits received by veterinarians not in private practice, 1987

	College or university	Federal government	State or local government	Armed Forces	Industry/commercial	All employers
Mean professional income ($)	50,739	45,477	45,500	43,365	61,249	51,995
Mean value of fringe benefits ($)	6,714	4,890	5,815	6,312	9,419	6,875
Mean value of fringe benefits as a percentage of mean professional income (%)	13.2	10.8	12.8	14.6	15.4	13.2

For veterinarians not in private practice, the mean value of fringe benefits was $6,875, ranging from a low of $4,890 for federal government veterinarians to a high of $9,419 for industry/commercial veterinarians (Table 4). Expressed as a percentage of mean professional income, the mean value was 13.2% in 1987, up from 11.6% in 1980. Compared with 1980 data, college or university veterinarians and industry/commercial veterinarians showed the most change from 1980 to 1987, increasing from 11.1% to 13.2% for college or university, and increasing from 13.7% to 15.4% for industry/commercial veterinarians. Mean percentages for government nonprivate practice changed less than one-half percentage point.

---

1. Wise JK. 1987 incomes of US veterinarians. *J Am Vet Med Assoc* 1989; 194:563-566.
2. Wise JK. Fringe benefits received by veterinarians, 1980. *J Am Vet Med Assoc* 1981;179:827-828.
3. Wise JK. 1987 Professional incomes of US veterinarians, by hours worked and years since graduation. *J Am Vet Med Assoc* 1989;186:815-817.